POWER

Volume 58 New York, October 30, 1923 *Number* 18

f Everyone Were Honest

I ATTE DED a dinner last night of an associ on for which the slogan, "I wou .ather die than be dishonest," was propos . While feeling that such a declaration ged pected to be taken literally, would transcend the bounds of honest sincerity — for the instinct of self-preservation is pretty strong — I was led to thinking how much it would mean to the world if everybody were really honest.

The effect upon our community life, upon our institutions, upon our individual relations would be tremendous — too tremendous for even suggestive review here. Think it over!

Scan the columns of your newspaper and see how much of the trouble and injustice and sorrow and strife there recorded would have been avoided if everybody were honest.

There would be prison and courthouse sites for sale and policemen and judges looking for jobs.

There would be respect and trust and mutual esteem in the hearts of some people who are now living simply for a chance to "get" each other.

Would it not be worth while to stress this fact in our schools, literature, churches and other cultural institutions?

In our old copy books we were made to write over and over, "Honesty is the Best Policy." The sentiment behind the motto is as crooked as the way our unaccustomed fingers used to write it.

The man who is honest only because he thinks he is going to make more by it than he would by cheating, would cheat if he thought he could get away with and profit by it.

It is only by submerging self-interest in an intelligent appreciation of and willingness to sacrifice for the common good that honesty can be made a common virtue.

Men are proud to make the supreme sacrifice for patriotism. They even applaud the fool sentiment, "My country! May she always be right, but right or wrong, my country!"

Would it not be well to expend some of the money and eloquence and energy that are being devoted to centralized self-interest, and narrow nationalism, upon an effort toward impressing honesty upon the race.

Universal patriotism would only array groups of men against each other. Universal honesty would lift the race a long step toward its goal of universal well-being.

F. R. Low

Remodeling Electric Railway Plant at Batavia, Illinois

By H. W. BROOKS
Consulting and Construction Engineer

At a cost of eleven dollars per kilowatt a plant installed twenty-two years ago was modernized and all equipment put in such good operating condition as to effect a reduction in the coal consumption of 20 per cent and the maintenance costs by the same ratio. It is believed that the station will give effective service for ten to fifteen years at economies attained by the modern plant of equal size. A subsequent article will describe a number of other interesting features of this plant.

THE remodeling of a medium-sized power plant and distribution system constructed as a model installation in 1901, and enlarged in 1912 with a view toward modernizing to the maximum extent consistent with the nature of the principal equipment installed, while the plant lines and substation were under a constantly increasing load during reconstruction, developed a number of interesting problems at the Batavia power house of the Chicago, Aurora & Elgin Railroad Co. By comparison with plants representative of present-day practice and taking into consideration possible adaptations of the equipment already installed, the problems appeared to be: (1) To decrease the coal consumption per kilowatt-hour approximately 20 per cent; (2) to reduce the annual maintenance costs approximately 20 per cent; (3) to reduce line and distributing losses to a minimum and at the same time to install sufficient additional conversion apparatus to permit a speeding up of the railway schedule on the entire system; and (4) to minimize the possibility of serious interruptions.

The station contains a 7,500-kw. 1,500-r.p.m. condensing turbo-generator and a 3,000-kw. 1,500-r.p.m. low-pressure condensing turbo-generator, both installed in 1912, and three 1,500-kw. and one 1,800-kw. engine generators driven by 32x64x60-in. cross-compound Corliss condensing engines at 75 r.p.m., installed in 1901. All the generating equipment is rated liberally, however, in comparison with present standards, tests having proved the continuous 40-deg. capacity of the station to be about 18,000 kw., with 20,000 to 22,000 kw. obtainable on the swings. Three-phase 25-cycle current is generated at 2,300 volts. Each generator is connected through a separate bank of transformers to the station high-tension three-phase bus functioning at 26,400 volts, and all switching is done on the 26,400-volt side.

In the boiler room there are eighteen 5,000-sq.ft. water-tube boilers equipped with chain-grate stokers.

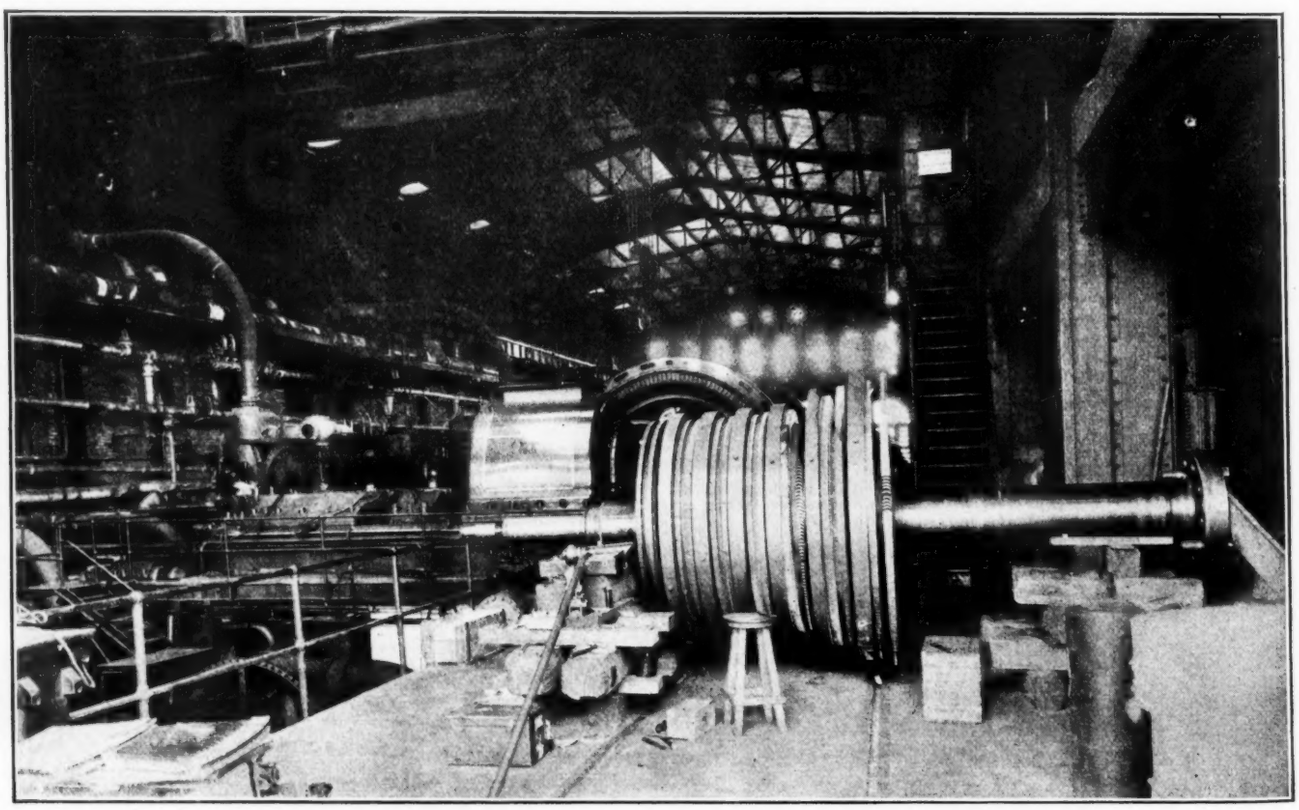


FIG. 1—HIGH-PRESSURE 7,500-KW. TURBINE UNIT UNDER REPAIR

Steam is now generated at 200 lb. pressure and 150 to 200 deg. superheat. First, a careful study of all available plant logs extending over a period of years was made, paying particular attention to all occurrences which were of an unusual character or which might have resulted in service interruptions or extraordinary maintenance. This was followed by an individual study of each major item of equipment in the plant with a view toward ascertaining in each case what changes, if any, would appear to be justified when capitalized on a 20 per cent basis. Tests were made on many items of equipment where insufficient data were available on the logs. Finally, a schematic station layout was made showing the principal test data on the various machines and a study made of the complete cycle of operations of the plant as a whole during both summer and winter. These three studies indicated a program of advisable improvements on which detailed estimates were prepared and accepted by the management.

Principal Changes Recommended and the Reasons Therefor

Briefly, the major changes decided upon, the reasons for recommending them and the benefits to be derived therefrom proved to be as follows:

1. Excavating beneath and lowering of four boiler settings, their stokers, hoppers and accessory equipment by 4 ft. to increase the height of the combustion chamber from 8 to 12 ft., thereby permitting increased combustion efficiency, particularly with the long-flaming high-volatile Southern Illinois and Indiana screenings burned.

Owing to the nature of the structure and equipment above the boilers estimates proved it more economical to excavate beneath the setting and lengthen out the steelwork underneath these boilers than the more usual method of raising the boilers, in spite of the fact that in so doing it was necessary to blast or pick out over 500 cu.yd. of stone underneath these four boilers. Small charges of from one-half stick to a stick of dynamite were used, each blast being covered carefully with wire netting and wooden ties. The blasts were thus so controlled as to eliminate danger to life or equipment in spite of the fact that the plant was constantly under load while this work was in progress. Accident, employers' liability and blasting insurance were carried, however, although fortunately there proved to be no occasion to utilize this coverage.

2. The replacement of the natural draft stokers on these four boilers with forced-draft chain-grate stokers equipped with side-wall tubes and pressure water backs. With the forced-draft stokers the fluctuations of the load, which are especially heavy in railway service, are accommodated readily through the greater inherent flexibility of this type, while the steady base load is carried by the natural-draft boilers at their most efficient rating.

The arches installed over the four forced-draft stokers offered a particularly difficult problem due to unusually high temperatures encountered. It was therefore decided to install two types of arches with a view toward standardizing later on the type proving more satisfactory. Both types have now been in service about eight months and apparently are still in excellent condition.

While the furnaces were being rebuilt, it was considered advisable to reconstruct the old baffles, which were

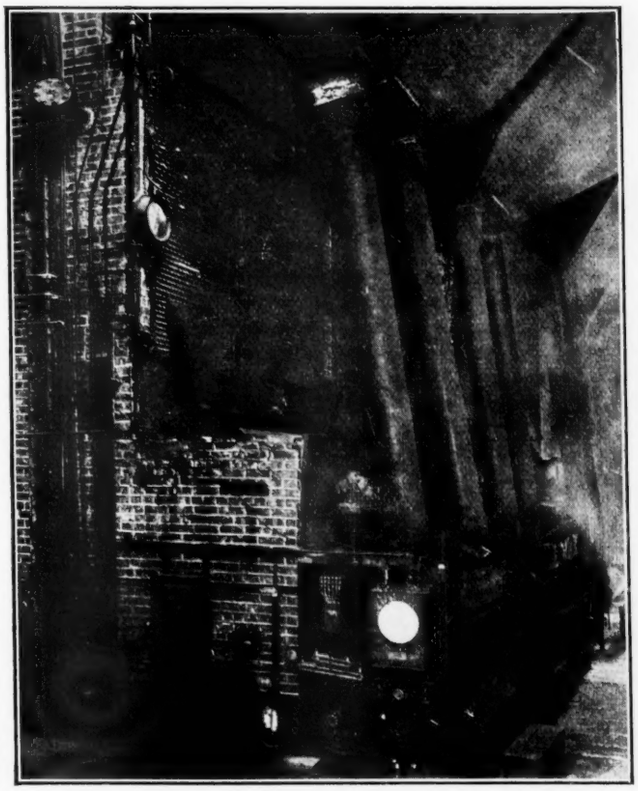


FIG. 2—STOKER RECONSTRUCTION NEARING COMPLETION, WITH COMBUSTION CONTROL APPARATUS IN FOREGROUND

of the standard (nearly) vertical type, replacing them with inclined baffles, thus tapering the gas passages to follow as closely as possible the reduced volume of the gases with their shrinkage at lessening temperatures. The lower entrance velocity aids the draft and relieves clogging of the gas passages by slag present in large quantities in the Illinois and Indiana screenings burned. Again, the maximum possible area of the bottom rows of tubes is exposed to the radiant heat of the furnace and the maximum heating surface is obtained in the first pass. This design also contemplated relieving the resistance wherever the gas had to be turned in a downward direction. Here, again, competitive installations were made, an interlocking-tile type baffle with plastic joints having been installed on two boilers and monolithic baffles shot with a cement gun on the other two.

Determining the Most Effective Mixture

To determine the most effective mixture to use in building the monolithic baffles, over twenty different aggregates utilizing different proportions of about a dozen different refractories and baked at temperatures corresponding to the center of the front baffle in the first pass, were tried. Each test block was baked while surrounding a short section of boiler tube. Inspection and tests were then made of each sample as to shrinkage, possibility of removal of the tube, number of hammer blows (such as might be encountered in turbining) to crack the sample, its resistance to water and the character of the fracture upon failure. The aggregate apparently proving most satisfactory was $2\frac{1}{2}$ parts of ganister screened through $\frac{1}{8}$-in. mesh with one part of portland cement and one part of ordinary fireclay.

Owing to the nature of the coal burned, some trouble was at first experienced with secondary combustion resulting in high CO and low CO_2. Experiments and tests with the Orsat, made by cutting in the arches holes of various sizes and at various locations for the introduction of excess air, resulted in entirely correcting this condition, practically eliminating the CO and increasing the CO_2 by 2 to 3 per cent. Dampers or gates over these air orifices will be installed later and calibrated in such a manner that the fireman always will know what setting to employ with a given fire condition and steam flow.

3. The installation of direct-current motors to drive the forced-draft stokers, fans and damper machines. These motors are calibrated specially as to speed to permit the application of the Benjamin automatic system of combustion control[1] which automatically adjusts the fire and draft conditions to the point of maximum combustion efficiency for any and all conditions of steam pressure and steam flow without attention by the fireman.

4. The design and installation of coal spreaders in some of the stoker hoppers to cut down the labor cost of firemen and to produce uniform fuel beds.

5. The installation of eight recording meters and draft gages to act as a constant check on the operation of the boilers at maximum efficiency.

6. Trial installation of the Lea recording coal meter, which, with the integrated steam-flow charts, makes possible a continuous boiler check on pounds of steam per pound of coal

The Lea meter, of which there now are but a few installed in the United States, though it is used widely in Europe, operates on the weir principle, motion from the stoker pinion being reduced to gage the travel of the chain grate while vertical motion of the fuel gate gages the thickness of the fuel bed. The constant obtained by test, multiplied by the difference of two consecutive meter readings, gives cubic feet of coal burned per unit of time, which can be converted readily to tons by daily or weekly weight samplings which easily give the constant for such conversion. Tests indicated that the accuracy would be within 2 per cent.

7. The installation of eight superheaters to obtain the decreased engine and turbine water rates possible with superheated steam at a final temperature of approximately 550 to 600 degrees.

8. The replacement of a large portion of a pneumatic ash-conveyor system which was in a rather poor state of repair, with a new steam-jet system for the purpose of reducing operating and maintenance costs thereon by making the system tight throughout. White-iron ash-conveyor pipe 1 in. thick was used, with a joint somewhat resembling Vanstone construction. Removable wearing backs were installed at the elbows, permitting easy replacements.

9. Installation of five boiler-water deconcentrators and a feed-water filter in the make-up line to minimize boiler cleaning and upkeep expense.

10. Purchase of cement gun for shooting furnace and arch repairs and other concrete and masonry work with a view toward approximately halving the labor costs.

11. Removal of all cast-iron fittings and valves and screwed flanges in the boiler and engine leads and the main steam header, and replacement with steel fittings

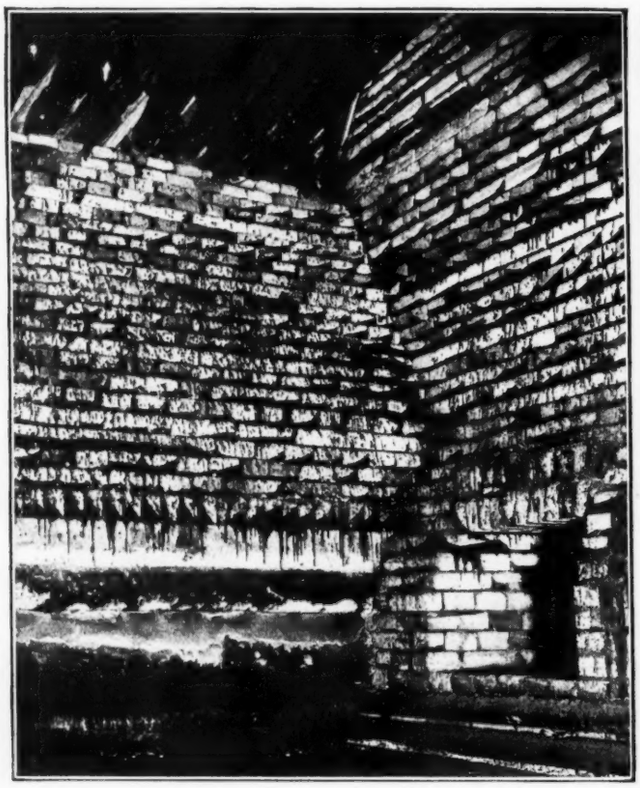


FIG. 3—FURNACE OF FORCED DRAFT CHAIN GRATE SHOWING PRESSURE WATERBACKS AND SIDE WALL TUBES

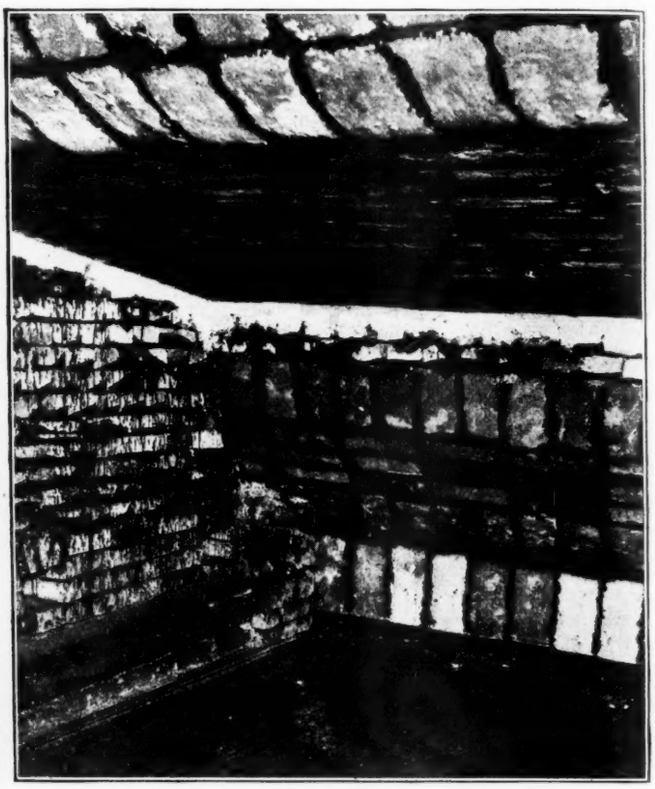


FIG. 4—SHOWS INTERIOR VIEW OF THE FURNACE LOOKING TOWARD THE ARCHES

[1] This system will be described in a subsequent issue.

and valves and Vanstone flanges to withstand superheated steam. Complete specifications on which the new header was purchased will be given in a subsequent article.

The replacement of the cast-iron parts of the header with steel was done on an old-fashioned single straight-line header with but two sectionalizing valves. There were no loops and no duplicate header available. Furthermore, some of the parts of the old header had to be utilized in the new one.

To do this with load constantly on the plant, sections of the new header of 12- and 20-in. pipe sometimes as long as 70 ft. were assembled and bolted up on the floor

NEW EQUIPMENT ADDED TO BATAVIA PLANT

4 stokers, forced-draft chain grate (Green)	Combustion Eng. Corp.
2 fire arches (Green)	Combustion Eng. Corp.
2 Fire arches	M. H. Detrick Co.
8 Superheaters (Elesco)	Superheater Co.
New baffles on two boilers (Turner)	The Engineer Co.
Automatic system of combustion control	The Benjamin Engr. Co.
Recording coal meter	The Lea Recorder Co., Ltd.
Steam-jet ash system (Detrick-Hagan)	M. H. Detrick Co.
Steam-flow meters	Bailey Meter Co.
Steam-flow meters	General Electric Co.
Draft gages, multiple-tube	Lewis M. Ellison
Coal spreader, stoker hopper	Universal Coal Spreader Co.
Filter, feed-water	Blackburn-Smith Corp.
Boiler-feed pump, 750 gal. per min.	Ingersoll-Rand Co.
Air pump, two-stage	Ingersoll-Rand Co.
Exciter set, dual drive, full automatic 300-kw.	West'ghouse Elec. & Mfg. Co.
Air compressor, 380 cu.ft., motor-driven	Ingersoll-Rand Co.
Two full automatic rotary converter substations, 1,000 kw.	General Electric Co.
Heat insulation	Johns-Manville
New flanges and fittings	Pittsburgh Piping & Equip. Co.
Gate valves	Chapman Valve Mfg. Co.
Nonreturn valves	Lunkenheimer Co.

and raised in one piece into position. During off-peak periods one of the sections of the header would be cut out through its sectionalizing valve and blank flanges introduced to sectionalize a portion of this section. Steam then would be turned into the part not sectionalized while the sectionalized part was removed and replaced, whereupon steam was turned on in the new section and another piece sectionalized. Not a single service interruption was experienced on this job.

12. Installation of heat-insulating materials and the recovering of all steam and hot-water lines, boiler drums and heads, etc., to cut down the heat losses in transmission. Rather interesting considerations governing the selection of this heat-insulating material will be given in a subsequent article.

13. Replacement of the cast-iron head of the 7,500-kw. turbine with a new steel head to permit operation at the increased temperature and the complete rebladding and repair of this machine to place it in efficient operating condition.

14. Design and construction of a desuperheater and attemporator for the purpose of automatically maintaining the temperature in the main steam header opposite the reciprocating engines at a point not in excess of 500 deg. F. at all conditions of flow. A description of this device will be given in a subsequent article.

15. Replacement of a turbine-driven hydro-flow air pump on the main turbine condenser with a twin two-stage steam-jet air removal pump with inter- and after-condenser and the consequent halving of steam consumption necessary for air removal. The hydroflow pump will be returned later to the makers for complete rehabilitation and conversion to a turbine-driven boiler-feed pump, the boiler feed-water supply being somewhat inadequate for a safe reserve.

16. The design and installation of a full automatic dual-drive exciter set for the purpose of constantly and automatically maintaining a station heat balance.

17. Installation of a 750-gal. per min. boiler-feed pump driven by a variable-speed motor functioning with automatic, constant-pressure, differential-speed-regulating control. This outfit provides necessary additional boiler feed-pump capacity as well as making possible a station heat balance during the summer when the condition of unbalance is somewhat over the capacity of the dual drive exciter set to rectify. Under the load conditions here prevailing, computations proved a power saving of 17 per cent by the use of speed-regulating control of the motor as compared with throttling control of the pump.

18. Installation of steam-flow meters to act as a check on operating economies of engines and turbines.

19. Redesign of central system of drainage for steam

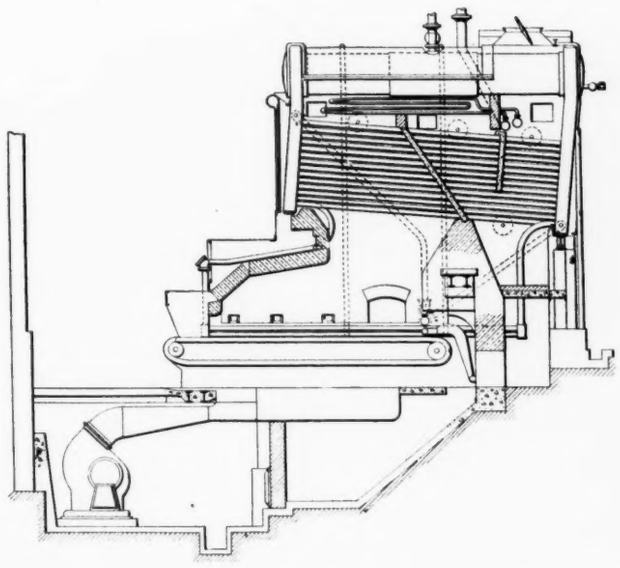


FIG. 5—SECTIONAL ELEVATION THROUGH BOILER SETTING

lines to reduce heat losses and maintenance expense.

20. Remodeling of feed-water heater by adding vent pipes and gate valves for the purpose of carrying feed-water temperatures higher than 212 deg. through slightly increased back pressures.

21. Installation of 380 cu.ft. motor-driven air compressor and storage tank to provide additional air necessary for boiler-tube turbines and other pneumatically operated tools and equipment.

22. Redesign and reinforcement of station bus, cable and wiring, the present output having outgrown the capacity for which they were designed.

23. Addition of 1,000 kw. of frequency-changer capacity to permit handling of additional 60-cycle commercial load recently acquired until the increase makes additional 60-cycle generating capacity economically advisable.

24. Installation of two 1,000-kw. full automatic rotary converter substations with all necessary equipment, making possible a faster and more frequent railway schedule at a minimum expenditure for labor.

These substations are equipped with load-limiting resistances in every feeder circuit and two steps of load-limiting resistance in the machine circuit. High-

speed circuit breakers are used in both these substations in all feeder circuits. The stations are of the semi-outdoor type, all possible equipment being placed outside. The building is just large enough to house the rotary converter and switching equipment and considerable care was exercised in the building design to provide sufficient ventilation therefor. The outdoor equipment consists of three single-phase 350-kw. oil-cooled transformers; 35,000-volt outdoor-type, oil circuit breakers, outdoor type current and potential transformers and oxide film lightning arresters.

In addition to these major items there were, of course, scores of minor changes, repairs and additions effected. All boilers were turbined and washed and a fixed cleaning schedule established. Masonry in furnaces and settings was placed in first-class condition, all steam or water leaks were sought out and eliminated, valves were repacked and reground, auxiliary turbines, engines and motors repaired and placed in first-class operating condition, main engines gone over in detail and completely rehabilitated wherever necessary. A new and complete system of power-house logs was laid out and put into use, making the reporting of repair jobs to be done automatic, while a maintenance log book keeps these jobs on the maintenance men's schedule of work to be done until completed. A complete new system of accounting was introduced, which will give automatically a record of the cost of labor and materials for each class of job, both for new construction and for repair work done or to be done. This system, without necessitating additional accounting, makes possible a much more accurate prediction of the annual maintenance budget or subsequent new construction budgets.

At the date of writing this article, not all the items of new equipment indicated herein are yet in service nor have the operating personnel yet had time to become so intimately acquainted with all details as to be able to say that maximum results are yet obtained. Similarly, work on deferred maintenance is still in progress. Consequently, definite figures just at this time might prove misleading.

Results to date, however, indicate that without doubt the objectives sought, as mentioned at the beginning of this article, will be attained. Estimated betterment of evaporation will probably approximate 9 per cent. Estimated decrease of turbine and engine water rates will approximate 12 per cent. The maintenance budget for the last half of 1923 is over 30 per cent less than maintenance expenditures for the last half of 1921 before the new work was started. Though not an original objective of the work, the safe output of the rehabilitated equipment has been increased about 2,000 kw. Line drops and distributing losses have been decreased materially, while the railway schedule has been speeded up and the service made more frequent. The possibility of service interruptions has been reduced to a minimum. The plant as remodeled, if kept in a reasonable state of repair, should render effective service for at least ten to fifteen years at economies comparing favorably with the average obtained in modern plants of equal size. Based on the station capacity the entire cost of the work will not exceed $11 per kilowatt. Including the new line and substation work the total unit cost will not exceed $15.

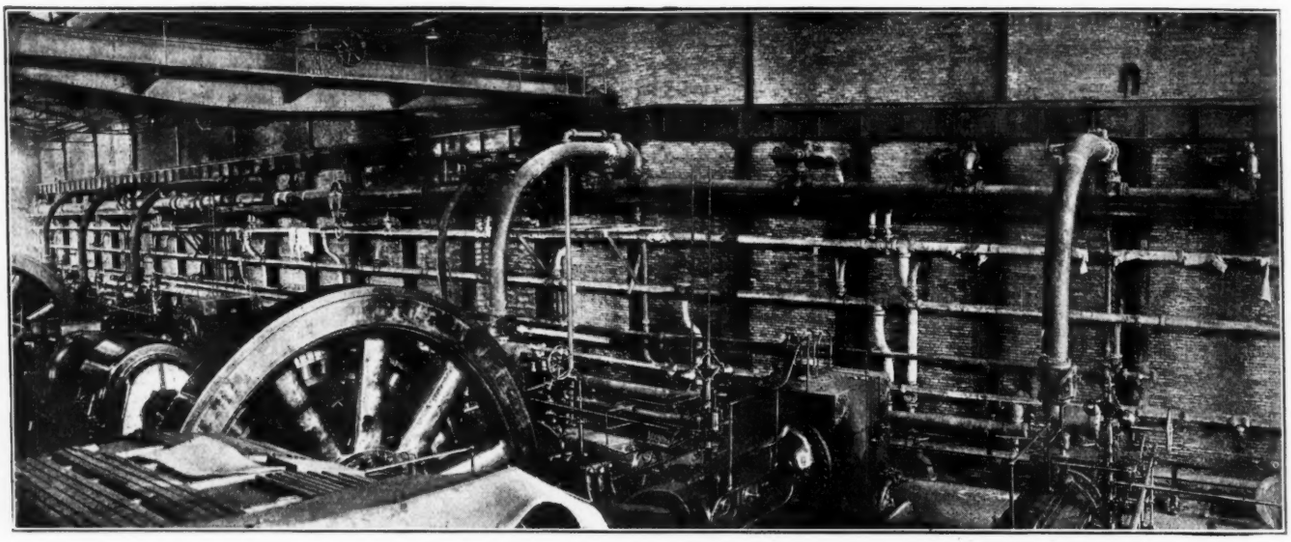


FIG. 6—ENGINE ROOM VIEW SHOWING REPLACEMENT OF CAST IRON WITH STEEL VALVES AND FITTINGS UNDER WAY

There are two general methods of gaging the load on a generator. By the usual method, the load is measured in kilowatts, or in amperes. In the second method the actual load or current is disregarded to some extent and the capacity of the generator judged by the temperature produced in the windings. By the former method it usually happens that in cold weather a generator may be loaded considerably more than the kilowatts would indicate. Temperature, as a measure of generator capacity, does not immediately indicate the true condition in case of sudden overloads. This is because some time element is required for the windings to heat up and register after an overload is supplied. It therefore appears that a combination of both methods should give best results.

The furnace described by George C. Adams in *Power*, Oct. 2, 1923, was patented by Mr. Adams under the dates of June 21, 1921, and Jan. 16, 1923.

Checking Ammeters and Relays

A Method for Testing Alternating-Current Relays and Ammeters by Using a Current Transformer Inverted to Obtain the Load Current

By RALPH BROWN*

WHERE relays and ammeters only are connected in the circuit, the variable-ratio characteristics of bushing-type current transformers do not prohibit their use. This type of current transformer possesses the advantages of low cost, compactness and freedom from dangerous stresses during short-circuits. Regardless of the difference in ratio of a bushing-type current transformer at light load and full load, if the ammeters are calibrated, with the relays in circuit, to read primary amperes, the indications of the instruments will be correct even when the current in the primary is low.

At a station where bushing-type current transformers with a rated ratio of 50 and 100 to 5 were used to energize the overload relays and an ammeter in two 44,000 volt lines, the question arose as to the accuracy of the ammeter readings and the relay settings. While ratio curves applying to the transformers were available, it was thought preferable to determine the actual ratio, hence the tests outlined in the following were made. These are of interest because a method was used by which useful data may be obtained by utilizing apparatus available at most power plants.

Fig. 1 shows a schematic diagram of the instrument and relay connections, the secondaries of the two bushing transformers per phase being connected in parallel. The primaries, which form the conductor passing through the oil-switch bushings, were connected in series. The ammeter switch is provided for connecting the instrument in series with either of the three relay windings without opening the secondary circuit. After taking one oil switch out of service and opening the disconnectors, the three oil-switch tanks were connected in series by using No. 6 wire, as shown in Fig. 2, without removing the conductors to the disconnectors. This connection was used to maintain the current passing through each transformer primary at the same value during the tests.

It was necessary to obtain energy for testing purposes from the station-lighting transformers. The neutral of these transformers was solidly grounded, therefore one wire was used and connected, as shown in Fig. 3, to a two-unit rheostat rated at 32 ohms, 5 amperes, the earth forming the conductor between the other side of the rheostat and the lighting-transformer neutral. The primary of a 50-ampere current transformer *T* was connected in series with the six primaries of the bushing transformers. One side of the secondary of the 50-ampere transformer was grounded and the other side arranged for connection to any rheostat contact, as in Fig. 3. In the figure connections for one phase only are shown. The secondary current was regulated by moving the contact arms of the rheostat and moving the secondary lead to any desired contact. It will be noticed that the 50-ampere transformer *T* was inverted; that is, operated to transform a low current at one voltage to a greater current at a lower voltage. A direct-reading ammeter *K* was connected in series with the primary of the step-up transformer to indicate the current flowing through the oil-switch bushings.

The first check on ammeter *R*, Fig. 3, was made by moving wire *L* over the rheostat contacts until the standard ammeter *K* indicated 10 amperes, which current gave a deflection of 7.9 amperes on the ammeter *R*. After obtaining a reading on phase *A*, and without

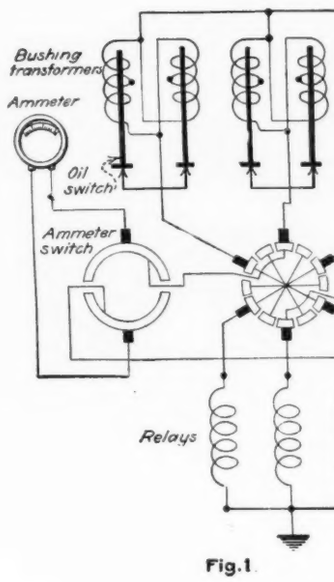


Fig. 1

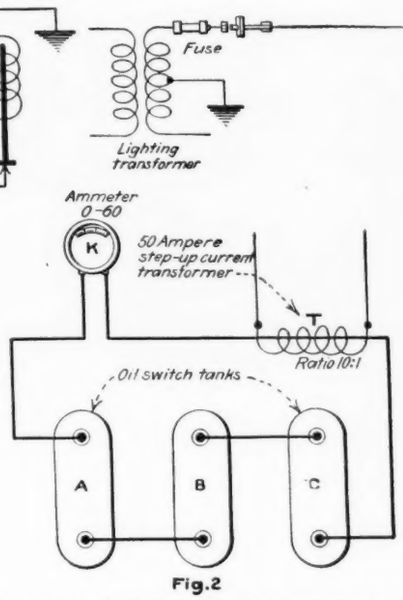


Fig. 2

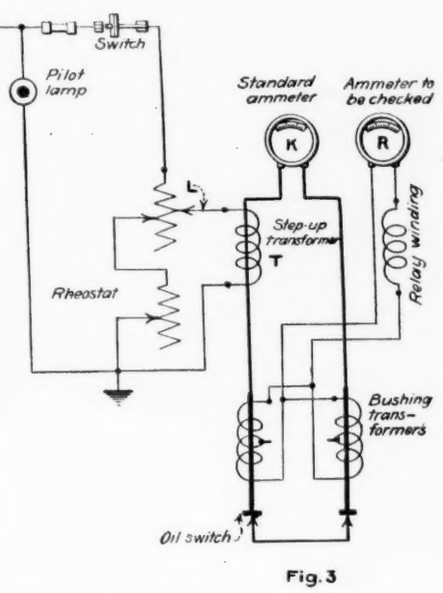


Fig. 3

FIGS. 1 TO 3—DIAGRAMS OF CONNECTIONS FOR TESTING AMMETERS AND RELAYS

*The Great Western Power Company.

changing the current in the primaries, ammeter *R* was successively transferred, by the ammeter switch, to phases *B* and *C*, and the deflections recorded. By increasing the voltage impressed across the secondary of the step-up transformer, the primary current was increased to 15 amperes and readings again taken with ammeter *R* connected successively to each phase, this procedure being followed each time the primary current was increased by 5 amperes, until the standard meter *K* indicated 50 amperes.

The instrument readings taken during the test made with the secondaries of the bushing transformers connected in parallel, Fig. 1, appear in Table I, and it will be seen that the secondary ammeter *R* generally gave a

TABLE I—AMMETER READINGS WITH SECONDARIES OF BUSHING TRANSFORMERS ON EACH PHASE CONNECTED PARALLEL-STAR, FIG. 3.

Secondary of Step-up Current Transformer		Primary Amperes	Readings on Ammeter *R* Connected to Bushing Transformers		
Volts	Amperes	Ammeter *K*	Phase A	Phase B	Phase C
0	0	0	0	0	0
7	1.1	10	7.9	8	8.7
12	1.6	15	12.9	13	13
16.5	2.1	20	17.8	18	18.3
20.5	2.7	25	23.1	23	23.5
24.2	3.2	30	28.3	28.1	28.7
28.2	3.7	35.3	33.5	33	34.2
32.5	4.2	40	38.2	38.9	39.9
36	4.6	45	44.2	44	45
43	5.1	50.5	50.2	51	50.5

lower reading than the standard, or primary, ammeter *K*. With 10 amperes in the primary the secondary ammeter indicated but 8 amperes in phase *B*, the error being great, while with 50.5 amperes in the primary the secondary ammeter reading of 51 amperes indicated a small error. Because the ammeter that was checked is read infrequently, the scale was not recalibrated, but a curve was plotted, based on the average of each set of three readings, showing the ammeter readings that will be obtained for primary currents from 0 to 50 amperes.

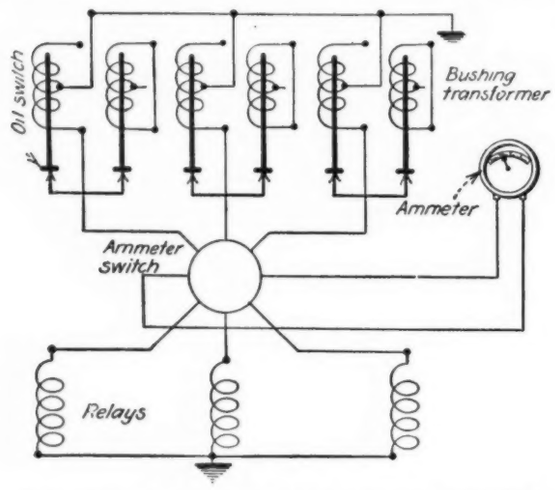


FIG. 4—CONNECTIONS FOR USING ONE-HALF OF TRANSFORMER WINDING FOR OPERATING AMMETER AND RELAYS

Shortly before the ammeters were checked, unbalanced readings were obtained on one line, and during the process of checking it was found that the secondary of one of the bushing transformers had become short-circuited and grounded. The defective winding was cut out of circuit and short-circuited, and as a ratio of approximately 10 to 1 was necessary because of the relays, this ratio was obtained by using the middle tap of the secondary winding in the other transformer in this phase. The secondary winding of a transformer in each of the other phases was also short-circuited and the middle tap in the secondaries of the other two transformers used to obtain a ratio of 10 to 1. This gave an arrangement of connections as indicated in Fig. 4. Current transformers, provided with a middle tap can be safely operated with half the secondary winding unused, provided these windings are placed on a core common to each.

The secondary ammeter *R* was checked in the same manner as when the parallel connection was used, and Table II shows that considerably less current was in-

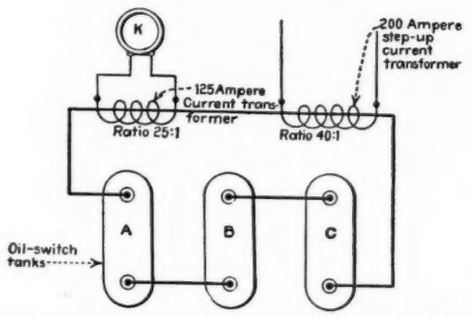


FIG. 5—OIL SWITCHES CONNECTED IN SERIES

dicated by the meter than was actually flowing in the primaries. The ratio with 50 amperes in the primary, using half the secondary winding, was but 9.2 to 1, and while this connection gives undesirable ratio characteristics, it was used until the damaged transformer was repaired. A calibration curve was also plotted to apply to this half-winding connection.

The 50-ampere step-up transformer required an input of 43 volts $\times$ 5.1 amperes $=$ 219.3 volt-amperes to circulate 50 amperes through the six bushing transformers, the ratio at 50 amperes being 1 to 9.8. Had this transformer been operated in the usual manner, the ratio would have been 10 to 1, giving 5 amperes in the secondary with 50 amperes in the primary.

With connections as shown in Fig. 5, the 50-ampere current transformer was replaced by one rated at 200

TABLE II—AMMETER READINGS WITH HALF WINDING OF SECONDARY OF ONE BUSHING TRANSFORMER PER PHASE CONNECTED IN STAR, FIG. 4

Secondary of Step-up Current Transformer		Primary Amperes	Readings on Ammeter Connected to Bushing Transformers		
Volts	Amperes		Phase A	Phase B	Phase C
0	0	0	0	0	0
12	1.1	10	5.7	6	6
15.5	1.7	15	10.1	10.1	10.8
20	2.2	20	15	15	15
24	2.7	25	19.8	20.3	19.9
28	3.2	30	25.2	25.0	24.7
32	3.7	35	31.2	31.9	31
35	4.2	40	35.1	34.9	34.9
39	4.6	45	41.1	41.2	40.4
43	5.1	50	46.1	46	45.8

amperes, having a rated ratio of 40 to 1. The primary current was read on an ammeter connected to the secondary of a 125-ampere current transformer. With this arrangement tests were made to determine if the excess-current relays functioned properly. Since the current through each relay was practically the same during any particular test, the primaries of the bushing transformers being connected in series, two of the relays were made inoperative by placing a piece of paper between their contacts, so that there could be no doubt as to which caused the oil switch to open.

It was found that with full voltage (104 volts) applied to the secondary of the 200-ampere transformer it would give only 86 amperes in the primary with the secondaries of the bushing transformers connected in parallel, Fig. 1, and 76 amperes with connections as shown in

Fig. 4. With 86 amperes in the primary the secondary current was 2.4 amperes, indicating a ratio of 1 to 35.8, the load drawn from the lighting transformer being 250 volt-amperes. As a cycle counter was not available, the relays were timed by using a stop-watch, and with the time lever set on 2 a current of 86 amperes would cause the oil switch to open 1.8 seconds after full voltage was applied to the secondary of the 200-ampere transformer. This period of time checked very closely with that given on the index plate of the relay.

While it is well known that current for testing relays and checking ammeters may be obtained by operating a current transformer inverted, the convenience of this method was demonstrated during these tests. Had a current of 86 amperes been obtained directly from the lighting transformer, 8.9 kva. would have been required, a larger conductor would have been necessary to transmit the current to the oil switches, and a large rheostat would have been necessary to limit the current through the bushing transformers. Had a current as great as 1,000 amperes been required for testing purposes, it could have been obtained by using a current transformer having a suitable ratio, at an input of less than 1 kva., whereas it would be impossible to draw a current approaching this value from the lighting transformer.

Figuring the Total Heat of Exhaust Steam

By A. G. Christie*

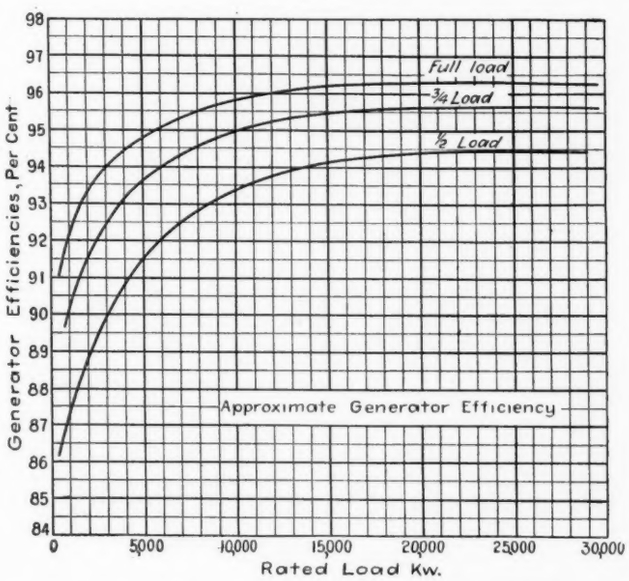
Engineers are frequently called upon to make calculations for heat balance or other purposes where correct values of the total heat of exhaust steam are important factors. This total heat can be easily found, particularly with steam turbines. The methods by which it may be computed for turbines will be outlined in the following paragraphs.

The first factor to determine is the total heat of the steam entering the turbine. This can be found from the pressure and total temperature or quality before the throttle valve of the unit. These are either given, or on an actual turbine can be readily measured. The total heat for the given throttle conditions can be found either in steam tables or on a Mollier chart. This total heat holds whether full or partial loads are carried on the unit. At partial loads the steam is throttled by the governor control valve to some lower pressure. However, throttling, while it reduces pressure, does not change the total heat content, since the work done is negligible and the quantity of heat lost in radiation is not appreciable. It is thus an easy matter to determine the total heat per pound of steam entering the turbine.

This heat can leave the turbine in three ways—(1) as radiation and conduction losses, (2) as work and (3) as heat in exhaust steam.

As turbines are now built, the high-pressure and high-temperature sections are usually of relatively small size and are covered with effective heat-insulating materials. The large exhaust ends are at low temperatures and radiate little heat. Radiation losses are thus of a relatively small order and may be neglected as such. Furthermore, there are no authoritative data available regarding radiation losses from turbine casings. Conduction of heat occurs along the shaft and casing to the bearing oil, particularly at the high-pressure end of the turbines of the impulse type when steam seals are used. This heat loss is difficult to estimate. However, it is usually accounted for by the heat in the bearing oil and for our purposes can be included as a bearing loss.

The output of the turbine generator is generally expressed as kilowatts at the generator terminals. However, the turbine itself has also to furnish the power equivalent to all the losses in the generator. The output at the coupling between turbine and generator can be found by dividing the output of the generator terminals by the generator efficiency. If many determinations are to be made at various loads, it will be found more convenient to plot the actual generator losses in kilowatts and use this curve rather than the efficiency



AVERAGE EFFICIENCIES OF PRESENT-DAY GENERATORS

curve. In fact, plotting the losses in kilowatts is an excellent way to check the accuracy of statements of generator efficiency.

Generator efficiencies are usually stated in the turbine specifications or can readily be obtained from the manufacturer. Where such data cannot be obtained, the values given on the accompanying curves may be used, which approximate present-day turbo-generator efficiencies.

If a generator is not used, the output at the turbine is generally expressed as brake-horsepower or shaft horsepower, in either case signifying the power at the coupling.

The steam inside the turbine generates more power than that delivered by the coupling for it has to overcome certain mechanical losses inherent to the turbine. The more important of these losses are the friction of bearings and thrust, the power to drive the oil pump and governor and the energy dissipated in water glands if used. In reciprocating steam engines these mechanical losses are usually of a significant amount, but in a turbine the mechanical efficiency is high and consideration of these losses might be neglected with only a small error on large condensing turbines. Furthermore, there is a paucity of data on these losses, so that further facts will be welcomed by engineers. A study of such data as are available indicates that the follow-

*Professor of Mechanical Engineering, Johns-Hopkins University.

ing figures may be taken to represent the total of these mechanical losses in per cent of the full rated output of the attached generator. This method of expressing these losses is a purely arbitrary one and is merely used for convenience.

1 to 2 per cent in large units of 5,000 to 30,000 kw.
3 to 5 per cent in condensing turbines 500 to 2,000 kw.
8 to 12 per cent in small non-condensing units.

The loss in the smaller units largely consists of radiation and conduction.

These losses should be expressed as a given number of kilowatts, as they are mechanical losses, not steam losses. Since the speed remains substantially constant at all loads and since these losses are dependent on speed, it will be apparent that the losses are practically constant at all loads and would therefore be apparently unrelated to power output.

The effect of radiation and conduction of heat from the turbine lessens the heat content of the steam in the same manner as the abstraction of work and for practical purposes may be considered as equivalent to so much additional mechanical loss. The mechanical losses already given have been increased to allow for these radiation losses.

The total output in kilowatts is thus the sum of the load at the generator terminals plus the generator losses at that load plus the mechanical losses. One kilowatt-hour equals 3,415 B.t.u. Hence the total output can be converted into B.t.u. by multiplying by 3,415. The total steam passing through the turbine at this load may be taken from test data or (if these are not available) from guarantees or meter readings. If the total power output in B.t.u. is divided by the total steam per hour consumed by the turbine, the result will be the number of B.t.u. per pound of steam actually converted into work inside the turbine casing.

The total heat in the exhaust steam can now be found by subtracting the B.t.u. per pound turned into work just found from the total heat of the entering steam. This method is illustrated by the following examples:[1]

1. To find the heat in the exhaust at 29-in. vacuum at best load (28,000 kw. on a 30,000 kw. turbine, 300-lb. gage pressure, 250 deg. F. superheat). Total steam passing through turbine at 28,000-kw. load is 265,000 lb. per hour. Generator efficiency 96.6 per cent. Total heat entering at 315 lb. absolute and 671 deg. = 1,352.5 B.t.u. Kilowatts at coupling = $\frac{28,000}{0.966}$ = 28,985 kw.

Let mechanical losses = 1.4 per cent = 0.014 × 30,000 = 420 kw.

Internal kilowatts of turbine = 28,985 + 420 = 29,405 kw.

One kilowatt-hour = 3,415 B.t.u.

Total heat converted into work inside of turbine per pound of steam = $\frac{3,415 \times 29,405}{265,000}$ = 378.9 B.t.u.

Total heat in one pound of exhaust steam = 1,352.5 — 378.9 = 973.6 B.t.u.

This corresponds to a quality of 0.884 at exhaust. If this steam exhausts into a condenser with condensate at 77 deg. F., the heat to be removed by cooling water per pound of steam = 973.6 — (77 — 32) = 928.3 B.t.u.

2. A 150-hp. turbine driving an auxiliary pump receives steam under the same conditions as the preceding unit, and at full rated load requires 3,015 lb. of steam per hour when exhausting at 16 lb. absolute back pressure.

To find the total heat in the exhaust steam, let mechanical and radiation losses = 8 per cent, or 0.08 × 150 = 12 hp.

Total internal horsepower = 150 + 12 = 162 hp.

One horsepower-hour = 2,546.5 B.t.u.

Total heat converted into work inside the turbine per pound of steam = $\frac{162 \times 2,546.5}{3,015}$ = 136.8 B.t.u.

Total heat in each pound of exhaust steam = 1,352.5 — 136.8 = 1,215.7 B.t.u.

This corresponds to a temperature of 346 deg. F. The saturation temperature at 16 lb. absolute is 216 deg. Hence, in this particular case the exhaust steam is superheated 130 deg.

These figures show that it is not difficult to calculate the total heat in exhaust steam under any given set of conditions with a reasonable degree of accuracy. A more accurate knowledge of this total heat will provide more exact data for condenser, heater and bleeder calculations.

[1] The heat values used are taken from Goodenough's "Properties of Steam and Ammonia."

Hints on the Operation of the Orsat Apparatus

By Peter G. Dahl*

In many cases, for example, when making a test for the combined boiler and furnace efficiency, it is desirable to analyze as many samples of the flue gases as can be obtained during the test. One should therefore be thoroughly familiar with the practical operation of the Orsat in order to be able to analyze the samples accurately and quickly. A few hints that have been proved to be helpful, are contained in the following statements.

The prevailing custom in bringing the water from the bottle up to the zero mark on the burette, in order to have 100 c.c. of gas at atmospheric pressure in the burette, is to open the three-way cock to connect the header to the atmosphere and then elevate the bottle slowly until the water rises to the zero mark, at which point the three-way cock is turned to shut off the connection between the header and the atmosphere. Should the water be allowed to rise above the zero mark before the three-way cock is closed, a sample of less than 100 c.c. of flue gas will be contained in the burette, and if the bottle should accidentally be lowered before the zero mark is reached, air will be drawn into the burette and the gases contained therein will be diluted, thus rendering the sample worthless. In both cases a new sample of gas should be drawn and analyzed.

An easy and sure way of obtaining the zero position is to draw in a sample of gas, shutting off the gas supply immediately after the water in the burette has drained to a point just below the zero mark and then elevating the bottle to compress the gas until the water rises above the zero mark. Then pinch the rubber tube connecting the burette and the bottle with the fingers of one hand and place the bottle on its shelf. Gradually release the pressure on the gas by allowing the water to drain into the bottle until the water in the burette has dropped to the zero mark, at which point the three-way cock should be given one complete turn, using the fingers of the other hand. This will subject the gas

* Efficiency Department, Commonwealth Edison Co., Chicago, Ill.

sample to atmospheric pressure. Before starting the analysis, check the zero position by placing the bottle in such a position that the water in it is on the same level as the zero mark on the burette. The water in the burette should then be at the zero mark also. The advantage of this method is that if the water should drop below the zero mark, the gas may be compressed again and another trial may be made in less time than it would take to draw in a new sample. Also, no air can enter the burette and dilute the gases by this process.

In many cases some kind of water or steam-jet aspirator is used in connection with a collecting bottle to obtain a continuous sample of gas. It is then important to place a pinch cock on the tube connecting the Orsat with the collecting bottle after the burette is filled with gas. This precaution is necessary because, when the three-way cock is opened to the atmosphere, a partial vacuum is produced in the burette, and this causes the water to rise above the zero mark and a sample of less than 100 c.c. is left in the burette when the three-way cock is closed, in which case it is necessary to draw another sample.

In order that the glass cocks may move easily, they are usually lubricated with vaseline. Its use is not entirely satisfactory when the Orsat is employed where high temperatures prevail, as is frequently the case when analyses are conducted in the immediate vicinity of uptakes and economizers. A more satisfactory lubricant can be made by adding beeswax or paraffin to pure rubber until a mixture of the desired viscosity is obtained.

Engineer's Troubles in a Prison Plant

By R. A. Reynolds

Being chief engineer of a large state prison for young men would be a unique event in the life of many engineers who have never had the opportunity of such experience. The industrial engineer may think that his lot is a hard one, but unless he has been connected with a prison job, he has yet to learn the true definition of tact, worry or responsibility.

Strange as it may seem, there is in prison work the same difference that exists in plants outside the walls of the "big house." A chief's job in a prison for "long timers" is usually much more desirable than in a place where short-term men are confined. This is true because with the long-term man the personnel of the operating crew can be kept intact for years, and when a fairly good force of men are gotten together, it is not a hard task to drill each man in his respective duties. When these conditions exist, fairly reliable service can be expected from the inmates.

One can imagine the glory of trying to operate a large power plant with young men, the majority of whom never before saw the inside of a plant. Combine this feature with the positive lack of initiative and dislike of responsibility on the part of the inmate, and you have a combination that is hard to beat.

I would like to give the reader some idea of what can transpire on a job of this kind in the short span of one week. These incidents are taken from the daily reports which form a part of a log system employed to keep the assistant warden informed of mechanical conditions about the institution.

In the particular prison of which I speak, the chief and his operating engineer alternated with the Sunday work. Hence I will start with Feb. 11 last, my Sunday on duty.

Sunday, arrived at 6 a.m. to relieve the night engineer, and after making my usual survey of the plant I seated myself comfortably in the engine-room office for a little chat with my inmate clerk. At 7:15 my phone rang. The warden was on the wire. "What in thunder is wrong with the hot water back there," he bawled. "I've been trying to take a bath for a half hour, and the longer the water runs the colder it gets."

I assured him that I would endeavor to locate the trouble at once. I walked out to the front of the institution and tried a faucet in the barber shop; finding plenty of hot water there, I headed for the warden's residence outside the walls. I was not long in discovering the cause of the cold water. The day before the inmate plumber had installed a wash bowl in the back hall, and he had reconnected the bathroom hot-water pipe to the cold-water supply.

At 9:30 a.m. the boiler repair man rammed a length of pipe into the gage glass on the feed-water heater and smashed it. This glass was 24 in. long. Not being able to find another glass of that length, I used two shorter ones and taped the joint with friction tape.

At 3 p.m. the warden was showing some fire marshals from the state capitol through the institution. The prison has its own fire department, manned by a crew of inmates. The warden gave the word to sound the whistle in order to demonstrate the efficiency of his fire fighters. I made for the boiler room and pulled the whistle chain. I heard a muffled grunt, and the next instant something landed on the sheathing above.

The Whistle Blows Off

As quickly as possible I climbed to the roof and found that the main body of the whistle had blown off. Upon investigation it was found that the valve located close to the steam header was leaking. This steam had condensed in the 2-in. pipe between the valve and the whistle, and when the valve was opened suddenly a column of water had shot up against the whistle base.

Monday morning started out on its good behavior, and nothing out of the ordinary happened during the morning run. At 1 p.m. the outside pumphouse man telephoned that the 40-hp. motor driving a centrifugal pump had burned out. I proceeded at once to the pumphouse and had the armature removed and taken to the machine shop. The shop electrician was set to work reinsulating the bar wound coils and the core. I made a note of all details and connections and gave them to the electrician for his guidance.

Four days later we returned the armature to its housing and applied the current. The speed was about four times normal. On checking over the connections, I discovered that the electrician had connected the two ends of the parallel-wound coils two bars apart instead of placing them in adjoining bars. The leads had to be unsoldered and correctly replaced.

At 2:20 p.m. a tee in the blowoff line behind the boilers cracked when the water tender attempted to blow down a boiler because of high water.

At 3:30 p. m. a return pipe on the spray system of cooling used in the cold-storage rooms of the ice plant clogged and flooded one room with brine, causing a loss of some provisions and about one-fourth of the brine supply.

At 5 p.m. the centrifugal cold-water supply pump in the engine room, operating on a 6-ft. suction lift, dropped its suction and ran away, the automatic cutoff having been removed. Before the pump could be stopped, the packing was burned and had to be renewed.

Tuesday, at 7:15 a.m., an underground cable burned out. It was caused by water getting into a junction box out in the yard. The burned cable was repaired and reinsulated again, and the junction box made as watertight as possible.

At 8:35 the circuit breaker on the feeder leading to the administration building went out. This lead-covered cable lay along the bottom of a tunnel in which about 6 in. of water had collected owing to a heavy rain. Evidently, the lead covering had been punctured at one time by other workmen in the tunnel.

At 4:30 p.m., on closing down the large Corliss engine unit for the day, it was found that the engine would not stop. A speed indicator belted to the main-shaft showed it to be operating at normal speed. The operating engineer finally located the trouble. A 1½-in. line that bypassed the main valve had been opened by some meddling inmate and he had forgotten to close it.

Wednesday was the banner day of the week for smooth operation. It is barber day in the engineering department. At 9 a.m. the hopper fillers in the boiler room decided to get a shave at the same time. As a result the hoppers ran empty and came close to shutting down the plant before the fires could be run back and the steam pressure boosted to normal again.

At 2:15 p.m. the circuit breaker on the line to the warden's residence went out. Upon entering the residence by way of the back hall and kitchen, I ran directly into the cause of the trouble. An idle porter had tried the little experiment of heating water with the iron by placing it in a pan of water. I began to wonder why the circuit fuse did not blow. Going below, I found that the fuse was missing and in its place was fastened a piece of baleing wire.

Thursday Was an Exciting Day

What Wednesday lacked in way of excitement, Thursday made up in full measure. The night engineer reported that at 4 a.m. the discharge line from the vacuum pump on the heating system had clogged for some reason. Not having any repair men on duty, he was powerless to locate the trouble. He had managed to tap the discharge line and run the water into a sewer behind the boilers. The vacuum pumps were in a basement under the engine room, and through numerous openings in the wall the discharge water was slowly filling the basement.

It was too cold to shut down the vacuum pump, and the 1¼-in. siphon was too small to remove the water from the basement. As there was no time to be lost, several pairs of hip boots were obtained and we began to disconnect the line. In the third ell from the pump we found a 4-in. pump valve wedged. How this valve had navigated two ells and about 100 feet of 4-in. pipe is still a mystery to me. We also cleaned a hatful of pebbles from the line, some as large as bird's eggs.

At 12:30 a new inmate engineer attempted to cut in the large engine unit. Through carelessness or confusion he closed the switch on a smaller unit standing at rest. The fireworks were spectacular. He nearly ruined the heavy knife switch and sent himself to the hospital for three days with a pair of badly burned eyes.

At 2:45 p.m. a handhole cap on the rear end of one of the big boilers began blowing water to such extent that the unit had to be cut out of service as quickly as possible.

Friday, at 7:15 a.m., the circuit breaker on a small electrically driven centrifugal pump went out. This pump is in a shaft about 30 ft. below the ground level.

The maintenance electrician disliked climbing down into the well, and from lack of inspection the commutator brushes had burned off and blackened the commutator, which had finally become so hot that the solder was melted from the commutator lugs.

At 9 a.m. the boiler cleaner was told to clean the combustion chamber on the boiler cut out of service the day before. He was instructed to pull out what he could from the outside with a hoe. However, he evidently wanted to cool the hot dust and make the job less disagreeable. Accordingly, he sprayed cold water into the chamber, and the red-hot mass of fine ashes underneath badly blistered and burnt his hands and face.

A large foundry is operated in connection with the institution. The heaviest power load occurs at pouring off time, usually about 3:30 p.m. A large electrically driven blower is used as a blast for the cupola and it is essential that there be no power interruption during this run. Shortly after 3 o'clock the smell of burning rubber was noticed in the engine room. I got busy at once and located the trouble behind the switchboard. The solder had melted from a lug on the foundry cable. I immediately stationed two inmates behind the board with the positive injunction that should that lug melt they would spend the rest of their natural lives in solitary confinement. I quickly made some thin copper wedges and drove these into the end of the lug, securely wedging the cable end into the lug. In that manner we finished out the run.

Saturday's Left-Over Troubles

Saturday morning, as usual, I had a mass of trouble left over from the night run. The gravity-feed oiling system to the engines had clogged at 5 a.m. and the night man had tried to blow out the obstruction, but only succeeded in jamming it tighter. The inmate pipefitter finally located the trouble after taking down most of the piping.

At 9:30 the ice-plant attendant attempted to put a new gasket on the head of the ammonia pump. In setting up the bolts, he succeeded in cracking the pump casting across a bolt hole. Ammonia sprayed from this crack when the pump was put in operation. A repair had to be made at once, and outside welders were called in. They attempted to weld the break, but the crack opened again as soon as cold.

The ammonia end of the pump had to be removed and taken to the welding shop. A preheating job turned out succeesfully, and at 8 p.m. the pump was put in operation again. At 4 p.m. a tube in the bottom row of one of the boilers showed a leak directly over the fire. A stream of water shot against the chain-grate stoker, and three links cracked. The boiler was taken off and preparations made to put in a new tube. Likewise the stoker was hauled out to be repaired.

I may mention that I stayed on that night until repairs were completed, rather than come back Sunday. At 11:30 I registered "out" in the guards hall and headed for home, anticipating how I would spend my precious Sunday off.

Diesel Engines Reduce Operating Costs

ONE of the problems confronting the small electric-light plant, regardless of the character of its ownership, is the question of excessive operating costs. Broadly speaking, many small plants are laboring under disadvantages that, unless a remedy be found, will force their discontinuance. The trouble is not due to mismanagement, although this does exist in many plants, but to the excessive costs of fuel. As one way of bringing operating costs within reason, many such plants have installed, and are still installing, Diesel engines.

For many years Neodesha, Kansas, had a municipally owned electric-light and water plant. At the time the plant was installed, coal was exceedingly cheap as was also labor, and since the oil engine had not attained its present popularity, steam-driven units were installed. As time passed, rising costs of labor and fuel became so alarming as to cause many to predict the ultimate shutdown of the plant and the granting of a franchise to a private corporation.

Feeling that something must be done, the city officials made an intensive study of other light plants and found that almost without exception those plants of under 2,500 kva. that were generating power at a low cost were oil-engine driven. Even towns located, as is Neodesha, close to coal fields, were finding the internal-combustion engine a means of keeping power costs within reason. After a study of the present power demands and of the probable future extensions of the load the authorities decided to purchase Diesel engines. The plan of installing two engines instead of a single unit was adopted; this was in a measure an unnecessary precaution, as the city found, on investigation, that the Diesel was as reliable as a steam unit and should be able to operate 98 per cent of the time.

The two units purchased were 550-hp. Nordberg two-cycle vertical Diesels each direct connected to a 350-kva. 2,300-volt three-phase 60-cycle generator. These engines are somewhat unusual in that each has five cylinders and is provided with both a compressor for the injection air and a pump which supplies the low-pressure scavenging air. This air is delivered into a manifold running along one side of the engine and communicating with ports cast in the cylinder just above the lowest piston position. By the use of port scavenging the cylinder head has but a central opening for the fuel valve.

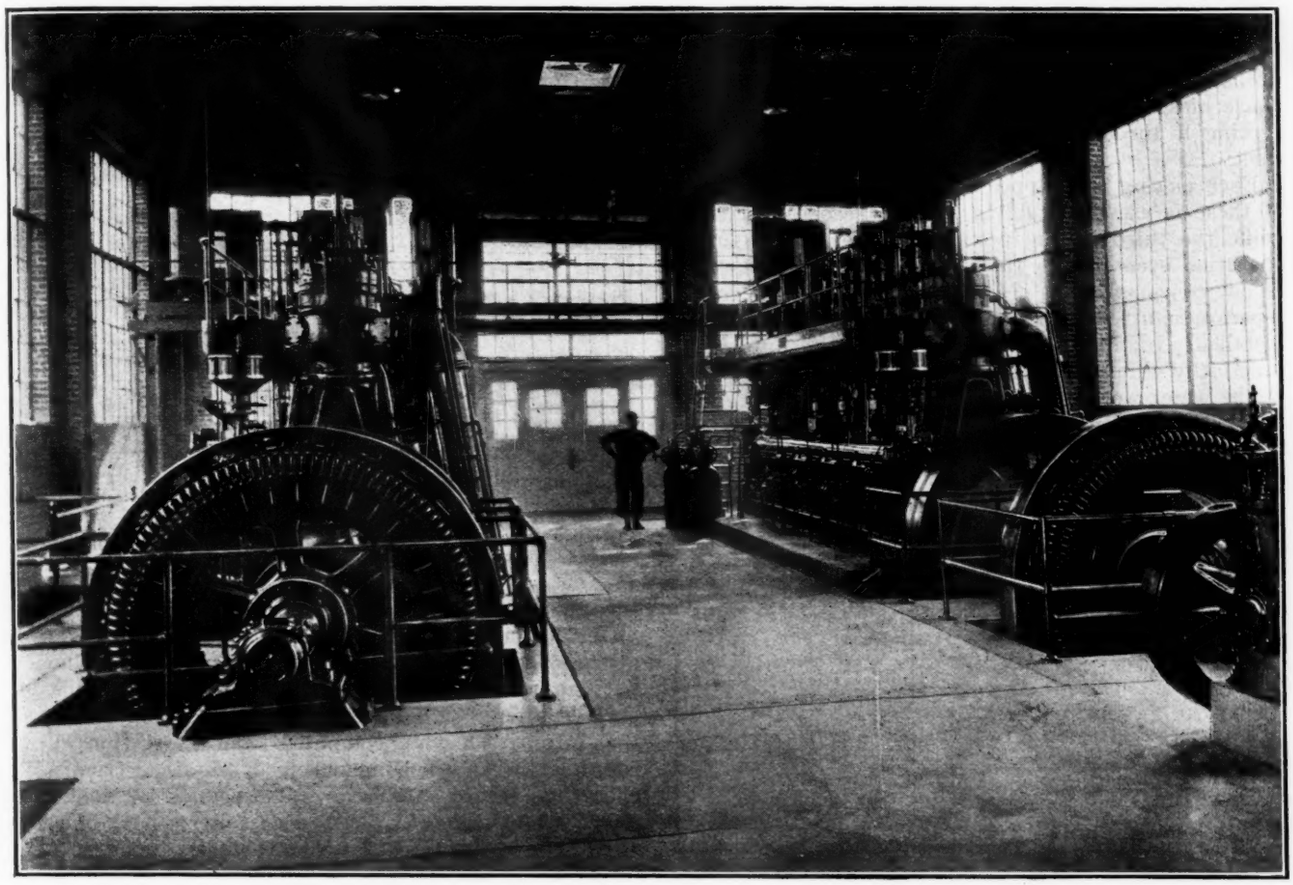


FIG. 1—NEODESHA, KANSAS, MUNICIPAL LIGHT PLANT

The camshaft is placed along the engine frame below the cylinders and carries cams which actuate the reach rods of the fuel and air starting valves. The governor controls the speed by varying the time of closing of the fuel-pump bypass valves.

The oil-storage tank is placed outside the building, the oil being pumped to the engine tank, which is placed immediately below the ceiling at one end of the engine

room. This elevation allows the oil to reach the engine fuel pumps under a slight head, thereby eliminating all danger of gas binding.

Each engine has its own lubricating-oil supply. The storage tanks are placed in the corners of the building, elevated enough to give a sufficient head to force the oil to the bearings. Each bearing is supplied by stream feed, and after passing through the bearing, the oil

COMPARATIVE OPERATING REPORT OF MUNICIPAL LIGHT & WATER PLANT OF NEODESHA, KAN., JULY, 1922 AND 1923

	Cost of Fuel	Lubricating Oils	Waste	Labor Cost	Boiler Compound	Packing	Total
1922.....	$2,353.87	$43.60	$6.60	$885.00	$45.95	$14.00	$3,349.02
1923.....	374.10	52.20	.50*	950.00	.....	6.33	1,383.13
	$1,979.77	$8.60	$6.10	$65.00	$45.95	$7.67	$1,965.89

* Reclaimed waste used.

drops into the crankcase. A pump geared to the engine shaft picks up the oil from the crankcase sump and forcing it through a cooler, lifts it into the overhead tank.

Each engine is equipped with three air bottles. One of these is used in starting, with a second in reserve, while the third is the injection air bottle. To insure operation even though the engine's built-in compressor is out of commission or in case all the air is lost, a separate multi-stage motor-driven air compressor was installed. In this way all danger of plant shutdown is practically eliminated.

The water-works plant contains motor-driven centrifugal pumps for water service. For breakdown service the authorities installed two 100-hp. Sterling gasoline

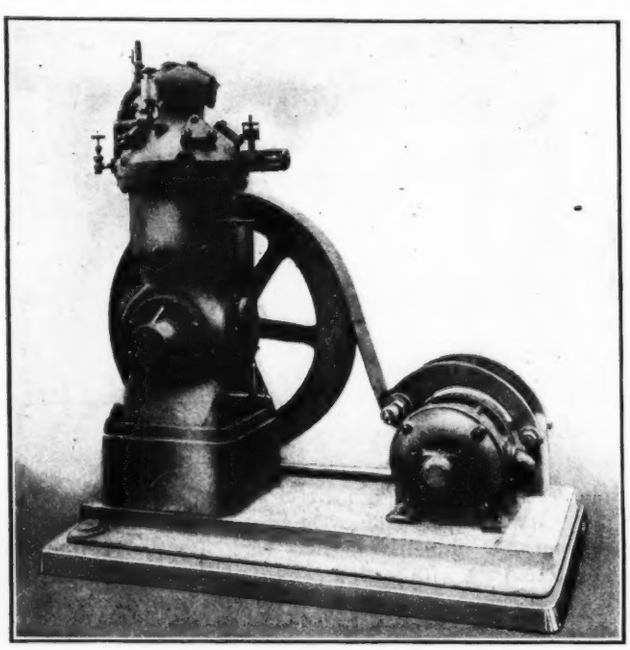


FIG. 2—MULTI-STAGE AIR COMPRESSOR

engines direct connected to centrifugal pumps. The addition of these engines, together with minor alteration in the fire service, caused the fire insurance companies to reduce the rates by 10 per cent.

The electric load is less than the capacity of one of the 550-hp. units, so that there is always a reserve source of power in case of unexpected peaks or in case of machine trouble. The operation of the plant has been exceedingly satisfactory.

While a single month's record should not be used as an exact measure of the average cost of operation, there is every reason to believe that the July costs are representative of what the plant will do in the future.

In July, 1922, the plant was steam driven and delivered 72,600 kw.-hr., while in July, 1923, the oil engines were in service and 117,800 kw.-hr. were put on the switchboard. Comparative costs were as shown in the table.

Efficiency System for Firemen

BY A. CHAS. LEARMONTH*

A system to work up competition between the firemen and promote boiler-room efficiency is used by the El Paso Electric Railway Co. in its main steam plant. The blackboard shown in the illustration is centrally located in the boiler room. For each shift this shows

	Fireman _____ Shift 11 p.m. to 7 a.m.			Fireman _____ Shift 7 a.m. to 3 p.m.			Fireman _____ Shift 3 p.m. to 11 p.m.			24 Hours			
	Pounds Coal per Kw.-hr.	Pounds Water per Pound Coal	Fireman's Eff.	Pounds Coal per Kw.-hr.	Pounds Water per Pound Coal	Fireman's Eff.	Pounds Coal per Kw.-hr.	Pounds Water per Pound Coal	Fireman's Eff.	Pounds Coal per Kw.-hr.	Pounds Water per Pound Coal	Pounds Water per Kw.-hr.	Fireman's Eff. Average
Mon.	2.94		90.5	2.61		94	2.47		106	2.62	7.44	19.45	
Tues.	3.02		84.5	2.57		96.5	2.39		109	2.58	7.46	19.15	
Wed.	2.64		95.0	2.65		97.0	2.45		109	2.54	7.48	19.00	
Thur.													
Fri.													
Sat.													
Sun.													
Average eff. cumulative current month			11 p.m. to 7 a.m.			7 a.m. to 3 p.m.			3 p.m. to 11 p.m.			24 Hours	
Average eff. previous 6 months			11 p.m. to 7 a.m.			7 a.m. to 3 p.m.			3 p.m. to 11 p.m.			24 Hours	
Highest average previous 6 months made by firemen			11 p.m. to 7 a.m. Name.....			7 a.m. to 3 p.m. Name.....			3 p.m. to 11 p.m. Name.....			24 Hours Name.....	

FIREMAN'S EFFICIENCY IS SHOWN ON BLACKBOARD IN BOILER ROOM

the pounds of coal per kilowatt-hour, the pounds of water per pound of coal and the fireman's efficiency.

The fireman's daily efficiency is calculated as follows: A theoretical curve was made showing the pounds of coal required per kilowatt-hour for varying loads on the station. This was computed from the station water rate and the known boiler efficiency obtained from past operating records. The average pounds of coal per kilowatt-hour for the average load for one hour of each eight-hour shift, divided by the actual pounds of coal for the average load for one hour of the eight-hour shift, gives a ratio that is called the fireman's efficiency.

The fireman's efficiency for each month is calculated by dividing the total pounds of coal used on his shift by the total kilowatt-hours generated on his shift, and this is divided by the total number of hours in his shift during the month. By use of a curve the theoretical pounds of coal per kilowatt-hour divided by the actual pounds of coal per kilowatt-hour gives the fireman's efficiency.

In addition a theoretical table shows the pounds of coal per kilowatt-hour for the hourly station loads. The number of kilowatt-hours generated each hour is posted on the switchboard so that it may be seen by the fireman. From this he is able to keep an hourly check on the generation and the coal used and tell just how efficiently he is operating his boiler room.

Averages for the month are posted on the blackboard, and with the change in shift of the fireman each month the efficiency of one man can be compared with that of another.

*Chief engineer, El Paso Electric Railway Co., El Paso, Tex.

Analysis of Steam-Engine Diagrams

By MARSHALL L. BARKER

In the issue of October 9 the author stated that a number of steam-engine indicator diagrams had been found whose expansion and compression lines agreed with the adiabatic. The theory that very little of the re-evaporation of the initial condensation takes place before release was advanced to explain this.

THE diagram shown in Fig. 1 is from a 28-in. cylinder unaflow and is practically perfect. The value of n for expansion agrees with the adiabatic, and the compression line is straight, although n is a little too high, probably due to an erroneous

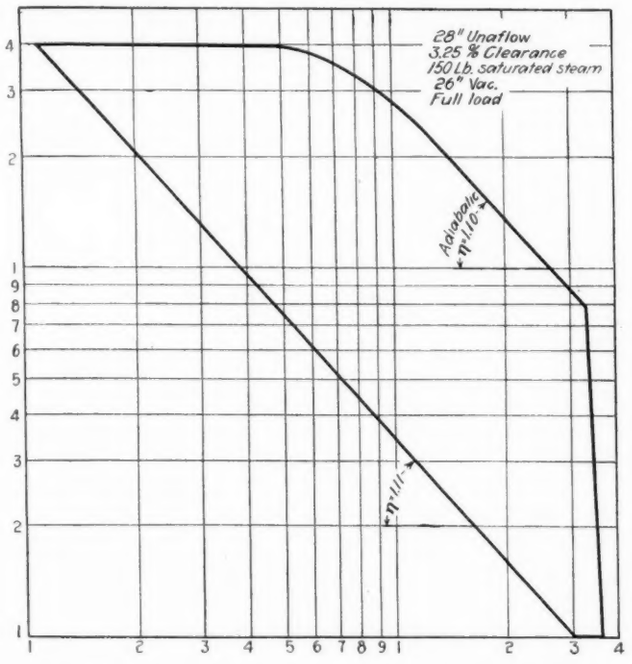


FIG. 1—DIAGRAM SHOWS ADIABATIC EXPANSION

assumption for the clearance. This engine has a jacketed head, yet gives the same exponent as do an unjacketed Corliss and another engine of the same make and design which have no steam in the jacket. This has led the writer to believe that the amount of initial condensation has but little effect on the value of n, for there is certainly more initial condensation in an unjacketed simple four-valve Corliss than there is in a jacketed unaflow engine. If the initial condensation affected the value of n, the Corliss, with its greater condensation, would have the lower value of n, but they are both the same.

Fig. 2 is from a 15x16-in. two-valve unaflow engine with valves that were known to be tight when the engine was not running. The compression line is not entirely straight, but near enough so that no fault can be found. This diagram was taken when the engine was carrying three-quarters load, and the expansion agrees with the adiabatic very well.

A diagram from the same engine at friction load appears in Fig. 3 and shows a very good expansion line, although the compression is a little too high. However, it demonstrates the principle that condensation does not affect the value of n to any appreciable extent, for even

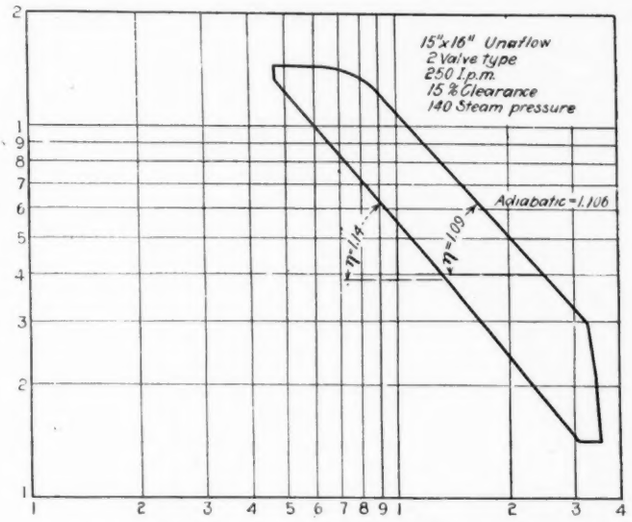


FIG. 2—ENGINE WITH TIGHT VALVES GAVE THIS DIAGRAM

in a unaflow engine there is a greater percentage of initial condensation at friction load than at three-quarter load. But these two diagrams show no noticeable difference in the expansion lines. A four-valve engine

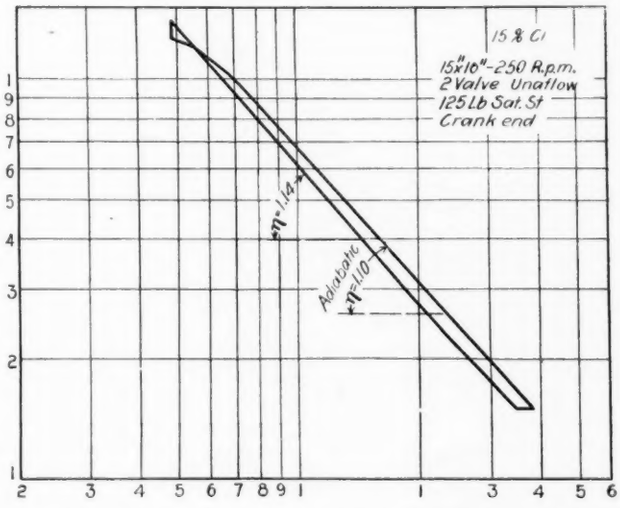


FIG. 3—ADIABATIC EXPANSION AT FRICTION LOAD

with poppet valves gave the same exponents, so that it was not a case of engine design.

Probably the most convincing proof of the effect of valve tightness on n were the results of tests on the same engine with two degrees of tightness of valves, or two values of n, for a similar degree of superheat. Fig. 4 shows a diagram from a test on a unaflow engine with jacketed heads in which the valves were known to leak badly, owing to filings and dirt in the steam line.

The expansion line, with its exponent of 0.72, as well as the curved compression line, shows how badly the valves were leaking. This test gave a Rankine-cycle efficiency of 52 per cent, which is poor for a unaflow engine.

The diagram in Fig. 5 is from the same engine two weeks later and reveals a good state of affairs, with the exception of a small amount of steam-valve leakage at the lower half of the expansion line. The difference in steam-valve leakage can be seen on the log diagrams but more forcibly in the steam rates, for although there was 8 in. less vacuum in the second case, the steam rate was 0.2 lb. less per i.hp.-hr. and the Rankine-cycle efficiency was nearly 20 per cent higher.

These diagrams show with more certainty the effect of leakage, as the two tests were run under practically the same conditions, the valve tightness only being changed.

The low-pressure diagram from a Corliss cross-

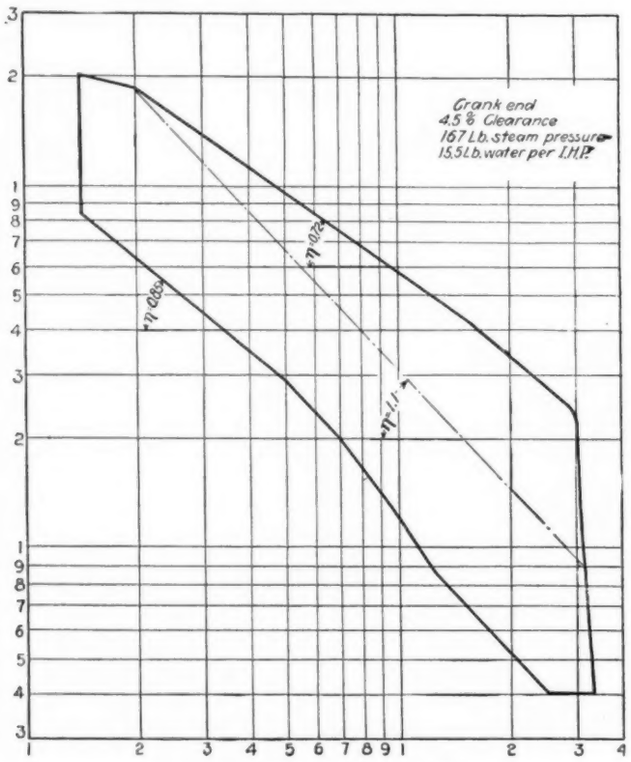


FIG. 4—VALVES LEAK BADLY

compound, if condensation has no very marked effect on the value of n, should be practically the same as the adiabatic. A log diagram from the 34x48-in. low-pressure cylinder of a condensing cross-compound Corliss at 96 r.p.m. is shown in Fig. 6. Saturated steam at 117 lb. gave an exponent of 1.08 for the expansion line in the high-pressure cylinder. The low-pressure cylinder expansion exponent agrees with this value very well, but the writer believes from the appearance of the compression line, which is too steep, that there is still some leakage. It is harder to keep the large-diameter valves in a low-pressure cylinder tight than the high-pressure valves, because the former have a little more clearance and possibly more of a tendency to rock than to slide, and so not wear to a true seat.

The effect of high superheat can be seen in the locomobile engine diagram, Fig. 7. With 200 lb. steam pressure and 280 deg. superheat this expansion line agrees very well with the adiabatic and the compression line is good. The high exponent of 1.20 shows the effect of high superheat.

From the diagrams shown and from about 170 others, 33 Corliss engines of eight different manufacturers, 29 unaflow engines of nine different companies and 6

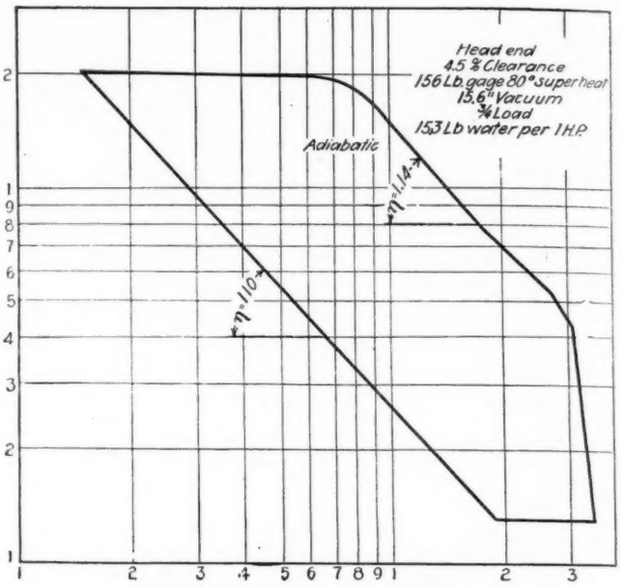


FIG. 5—RESULTS AFTER ADJUSTING VALVES

poppet four-valve engines from three concerns, the writer cannot agree with the present theory on the subject and has come to the following conclusions.

The value of n, when different from the adiabatic, is determined primarily by the amount of steam leakage past the steam valves, and to a smaller degree by ex-

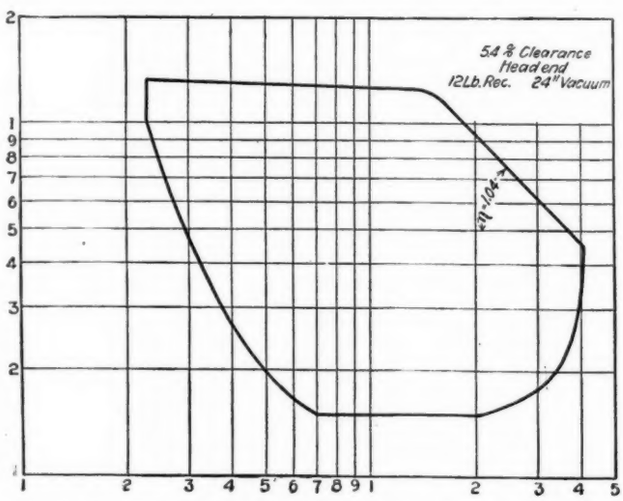


FIG. 6—LOW PRESSURE CYLINDER GAVE ADIABATIC EXPANSION

haust-valve or piston leakage. In other words, the percentage of moisture or initial condensation has no material effect on the value of n if the valves, pistons, etc., are tight, but it is determined by the original steam conditions at the throttle. If the valves are tight, Corliss and unaflow engine diagrams will have the same exponent, but the steam consumption will differ.

To sum up some of the minor conclusions, it was

found (1) that a leaky valve can, and quite often does, give a straight expansion line on the log paper, although the compression will invariably be curved; (2) the percentage of volumetric clearance can be estimated to within an error of 10 per cent if the leakage is rather small, by moving the points on the log chart until the two lines become parallel, then figuring the correct clearance; (3) for ordinary conditions of operation with saturated or wet steam, if the valves are tight and the

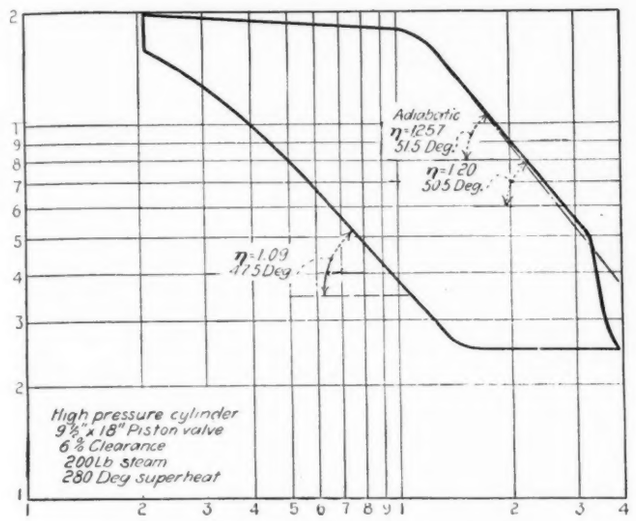


FIG. 7—LOG DIAGRAM FROM LOCOMOBILE

correct clearance used, the value of n will be 1.10 plus or minus 0.02 for the expansion line and about the same for compression.

The percentage of clearance, if wrong, will not affect the expansion line to any marked extent at ordinary cutoffs of from 10 per cent up. The lines are affected by an error in clearance directly as their distance from the zero of volume.

Out of the 170 diagrams examined by logarithmic plotting, only 24 could be classified as having come from an engine with tight valves. This number represented 18 different engines, out of a total of 68. This would show that about one out of three engines had tight valves.

The general statement might be made that if diagrams from any test were examined, the exponent would be found to agree closely with the adiabatic for the steam conditions, if the results were up to what could be considered very good for that class of engine. Likewise if the exponent was 0.1 to 0.2 lower than the adiabatic, the results would be poorer in proportion. When the same engine can be made to give an exponent varying from 1.14 down to 0.80 with the same degree of superheat, it very naturally leaves only leakage to account for the difference, because the initial condensation would be the same for the same load and superheat.

High wages, high prices of important raw materials and resistance to price advances on the part of consumers have combined to restrict profits in many industries, but this is a thoroughly sound situation. Business peril lies in easy profits.

If you smell gas or gasoline, and look for it with a lighted match, it is probable that you are about to start on a long journey.

Operation and Effectiveness of Flue Blowers*

During the past heating season a series of tests were made to determine the loss in heat transmission due to the collection of soot on boiler tubes. The tests were run on a 13,000-sq.ft. Stirling type boiler, with baffles and flue blowers located as shown in Fig. 1. The pressure of the steam used by the blowers was 125 lb. gage, this being plant pressure. The flue-blower elements are 14 ft. long, having twenty-six ⅜-in. nozzles.

The boiler tested was put in operation on Oct. 24, after being thoroughly cleaned and overhauled during the summer months. The first tests were made on Nov. 1, after the boiler had been in operation for 130 hours. Other tests were made after 560, 1,030 and 1,610 hours' operation, respectively, with the results indicated in tests Nos. 1 to 4 in Fig. 2.

Throughout the season the curves show a steady increase in the temperature of the gases, although the flues were blown twice daily, the first time in the morning just before the load was picked up and the second

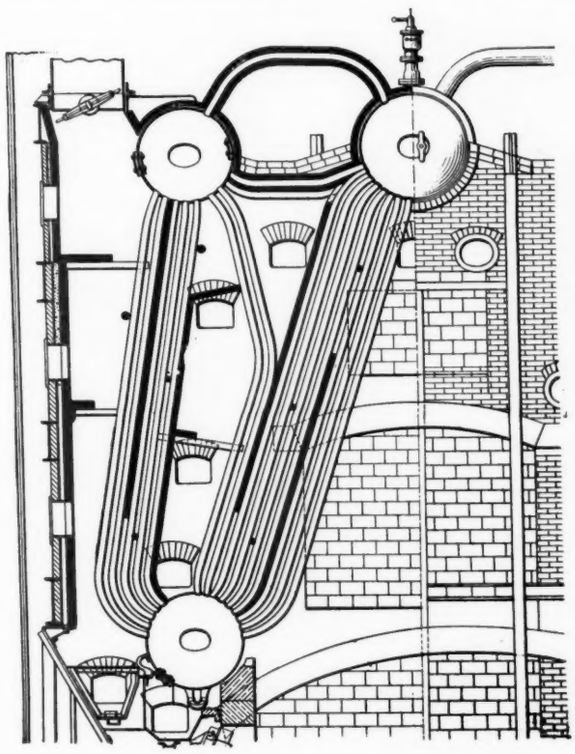


FIG. 1—SHOWS LOCATION OF BAFFLES AND FLUE BLOWERS

between 3 and 5 p.m. At night, when the boiler was running at low rating, the tubes in front of the first baffle were blown by telescopic units, installed because the ordinary flue-blower elements would not stand up in the high temperature at the top of the combustion chamber. The telescopic units are at the top of the first pass, where the most trouble with soot collection has been experienced. The soot originally collected on the tubes in large lumps, hindering the passage of the gas and causing high furnace temperature, but with

*From report of the Station Operating Committee of the National District Heating Association. Presented by R. G. Felger, of the Detroit Edison Co.

these new elements much of the trouble has been eliminated.

After the last series of tests were made (1,610 hours of operation), the boiler was taken down and cleaned. The front bank of tubes was washed, while the back tubes were scraped and the soot blown off with air. The inner surfaces of the tubes were not cleaned, for it was desired to obtain the loss in heat transmission due to the mud and scale collection from the water. After this cleaning process the boiler was again put into service and another series of tests made. Curve No. 5 in Fig. 2 shows the results obtained.

If these results are compared with the data of the test preceding the cleaning of the boiler, it will be found that the actual loss in heat transmission due to the soot was about 5 per cent. By comparing test No. 1 with test No. 5 it can be seen that the loss due to scale on the inside of the tube was about 2 per cent. These tests proved conclusively that the greatest loss in heat transmission was due to soot adhering to the tube surfaces. As previously stated, this loss amounted to 5 per cent, cutting down the efficiency of the boiler about 2.6 per cent, which means a loss of about 3 per cent of the coal burned. From these results it was decided to take down each boiler every six weeks, to give it a thorough cleaning and if possible clean the inner tube surfaces once every four months.

As to the water used in the heating plants, 90 per cent of the total used in the boilers is Detroit River water, the remaining 10 per cent being return water. The raw water is treated with soda ash in the feed-water heaters, then passes into live-steam purifiers, from which it flows by gravity into the boilers. Most of the scale-forming material is dropped in the purifiers, but of course some of it passes into the boilers, where it is dropped as a carbonate, which is

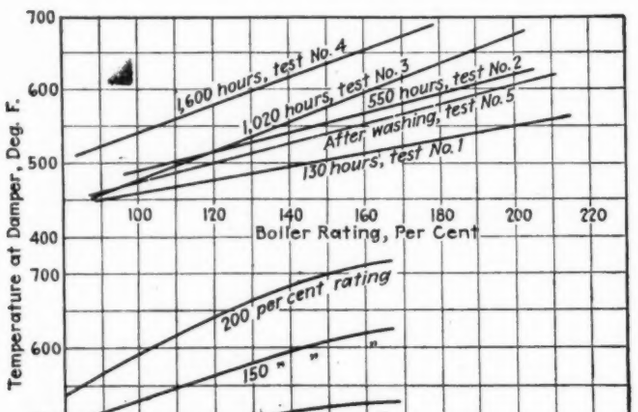


FIG. 2—SHOWS THE RESULTS OF TESTS

largely removed by blowing down. With this treatment the amount of scale forming on the tubes is slight.

As a further study of the effect of soot blowers, all the blowers in one pass of a boiler, with the exception of one located just about in the center of the pass, were disconnected. This was done to find the exact area of blower effectiveness. After the boiler had been in operation for about four months, it was found that the tubes were in good clean condition within a radius of five feet from the blower, as indicated in Fig. 3. Beyond this point the soot was quite noticeable, the quantity increasing gradually. At a distance of six feet from the blower the deposit of soot became bad, being a rather hard, scaly accumulation. This very likely was caused by the steam striking the soot after its energy had been spent, moistening it each time the blower was used, then drying out as soon as the

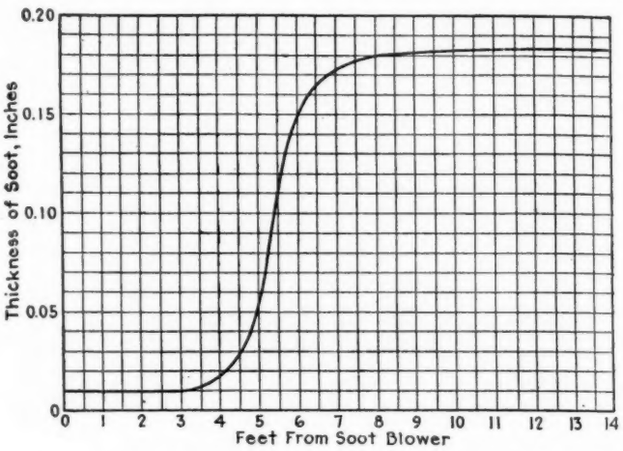


FIG. 3—SHOWS THICKNESS OF SOOT AT ANY DISTANCE FROM SOOT BLOWERS

steam was turned off. Beyond the 6-ft. radius the soot was about $\frac{1}{4}$ in. thick, but, being in a powdered form, was easily removed.

It is difficult to say just how frequently the flues should be blown, the proper period probably being entirely different for various boiler installations. During the tests of a "W" type Stirling boiler at the Conners Creek power house last year, four tests were made to determine what effect varying the time intervals between blowing the flues would have on the temperature of the flue gas leaving the boiler. The following conclusions were reached:

Taking into consideration the labor and maintenance costs directly influenced by the frequency of blowing flues together with the quantity of steam required per blow, an economic balance is obtained at 12.5 hours, assuming a constant rating of 200 per cent. Boilers banked at night should be blown only once a day. The foregoing is a literal interpretation of the test results, which does not indicate exactly the proper procedure, but serves more as a check on present practice.

Where the circulating water is corrosive, the material of condenser tubes must be chosen with especially high resistance to corrosion. Pure nickel or alloys with a high proportion of nickel would meet this requirement, but solid tubes of such material have not hitherto been available. I am able to state, however, that extremely promising results have lately been achieved in the production of solid-drawn tubes of Monel metal. Should the present experiments result in the production of tubes on a commercial scale, it would afford a complete solution of this trouble.—*James G. Weir.*

The first Curtis turbine built by the General Electric Co. was of 6,700 hp. capacity, or 5,000 kw. This was a vertical-type machine installed in 1903 in the Fiske St. Station of the Commonwealth Edison Co., Chicago.

EDITORIALS

F. R. LOW, EDITOR

Value of Losses in Hydro-Electric Plants

GUARDING against the accumulation of small losses that in the aggregate amount to a surprisingly large item, is one of the important problems in the generation and distribution of power. In the modern steam plant these losses are well recognized and their prevention carefully watched. Steam leaks from joints, packing glands, etc., are no longer tolerated in well-operated plants. The heat losses through bare surfaces have been carefully evaluated and heat insulation intelligently applied. The bad effects of leaky and improper furnace settings are given careful attention in both design and operation. In like manner every part of the modern steam plant is considered from the viewpoint of preventing the small losses as well as the larger ones, in order that the most economical operation may be obtained.

This practice of giving attention to every possible waste is in evidence in but few water-power plants although in some of the larger stations there has been during the last few years a gradual awakening to the possibilities of careful study and prevention of losses in hydro-electric plants. These losses are many in number and vary somewhat for different installations. Considerable loss of water frequently occurs through the turbine seal ring. What this may amount to even in a small plant, was shown recently in a Western station when the output with the same volume of water was increased from 1,440 to 1,670 kilowatts simply by renewing the seal rings. This saving at one-half cent per kilowatt-hour amounts to over eight thousand dollars a year.

Unless proper type penstock valves or gates are installed and are closed when the unit is shut down, water is wasted through the guide vanes all the time the unit is out of service. Not only this, but the wear on these parts may be increased by corrosion and erosion, which in turn increase the water loss when the unit is idle and may impair the efficiency when in operation. Those familiar with hydro-electric plant operation know that it is not uncommon to have to apply a brake to prevent the revolving element from turning after the turbine gates have been closed. The loss of water under these conditions will amount to a considerable part of that going through the unit under full-load operation.

Recent tests made on a large impulse wheel showed that the difference in efficiency of the unit when operating with a somewhat worn nozzle and when operating with a new nozzle represented about a thousand dollars a month. This saving amounts to several times the cost of installing a new nozzle, and emphasizes the importance of careful attention to maintaining high efficiency in hydro-electric units.

Another common source of loss in hydro-electric plants is clogging of the racks with trash. The top part may be kept clean by hand raking, while the bottom parts are closed with logs and trash unless proper means are provided for removing these obstructions. A loss of head of six inches may look like a small item, but where ten thousand cubic-foot-seconds of water is involved, it amounts to a loss of about five hundred horsepower, which at one-half cent per kilowatt-hour reaches over thirteen hundred dollars a month.

Although but few of the many ways that losses may occur in hydro-electric stations have been enumerated, they indicate what the cumulative effects of such losses may be and the necessity of careful consideration of ways and means of eliminating or reducing them to a minimum. Of course in some plants an excess of water is available and in such cases some of the losses may not be of such serious moment, but even in these plants there is much to be said in favor of economical operation.

Base-Load Power Plants

ENGINEERS frequently talk of certain new stations as base-load power plants, meaning that such plants will be given the constant base load of the system and hence will operate at high load factors. Such constant high loads tend toward high efficiency in operation. The high load factor will warrant the investment of additional funds in special equipment to secure higher operating economy than in plants having the usual load factors. The fluctuating load on such a system will be carried in general by one of the older and less economical stations.

The argument that a certain station can be used as a base-load plant has been used to justify special and expensive equipment and particularly high steam pressures. It is, therefore, pertinent to inquire when a station or a portion of station equipment should be considered as a base-load plant. In general such equipment should be considered as base-load plant only for such time as it is the most economical portion of the system from the point of view of station operating cost. It is natural to expect a decrease in the efficiency of a plant with increasing age. Surfaces corrode, turbine blades are eroded and become less efficient, propeller blades of pumps wear away, and the plant must reflect this increasing decrepitude in decreasing costs. Hence the older equipment should naturally be less efficient than newer, and therefore, the newer equipment would become the base-load plant.

But power-plant equipment is installed to operate for a long term of years. In designing whole stations as base-load plants, the natural inference therefore is that no great improvement in economy through perfection of machines or adoption of new methods may be expected during the life of the plant. This is not a reasonable assumption, for there is every indication that improvements will be made in the design of power plants in the near future. Higher pressures and superheat, bleeding for feed and for air heating, reheating

between stages, air preheaters and high-pressure economizers, pulverized fuel, and improved designs of main turbines and auxiliaries are factors that will greatly modify future designs and whose employment will tend to improve station economy. In view of these tendencies it seems unwise to assume that any station now under construction should be considered as a base-load plant during its whole useful life.

With these thoughts in mind it is pertinent to inquire whether some engineers have not unduly increased their investment in plant equipment by assuming that the equipment under consideration will be used for base load. If it can be base-load plant for only a portion of its life, then obviously too high load factors were used in the initial calculations and the use of certain special equipment may, therefore, be questionable for the true conditions of operation during the whole life of the plant.

Boiler Rating

The West Penn Company has got ratings of 450 per cent out of its boilers at the Springdale Station with underfeed stokers, and the Buffalo General Electric over 400 per cent, also with underfeed stokers.

THE initiated know that boilers are customarily rated at ten square feet of water-evaporating surface "per horsepower"; that a boiler horsepower means the ability to evaporate 30 pounds of water at 100 degrees F. into dry saturated steam of 70 pounds gage pressure. This is equivalent to three pounds of water per square foot of heating surface under these conditions, and nine or ten per cent more even at the present higher pressures with the hotter feed water now generally available.

How much simpler it would be to say that the West Penn Company had evaporated as much as 13.5 or 14 (or whatever it is) pounds of water per square foot of water-heating surface of its boilers at Springdale and, if one wanted to be sufficiently precise, that this is equivalent to so many pounds from and at 212 degrees or, better, to so and so many units of evaporation, the unit of evaporation being that which would require the transfer of 1,000 B.t.u. per hour instead of 969.7, 970.4, 970.7, etc., according to the steam table used.

Negligence in Boiler Repair and Inspection

WITHOUT minimizing the importance of boiler inspection it is well to call attention to the equal importance of employing only conscientious and trained men in boiler repair work. In this way there is a double check, and the chances of both the repair man and the inspector slipping up at the same time are greatly reduced. This equal importance of repair and inspection is brought home forcibly by a recent report of the Bureau of Locomotive Inspection of the Interstate Commerce Commission. In this report the death of one man, the severe injury of another and the complete destruction of a locomotive boiler were laid to incompetent repair work passed by incompetent or unconscientious inspectors.

The report shows that while the immediate cause of the explosion was the weakening of the crown sheet by low water, a contributory cause was to be found in the presence of several autogenously welded seams and patches in the firebox and, in particular, a decidedly defective welded seam near the center line of the crown sheet. Only twelve days before the explosion the inspector had pronounced the condition of flues and firebox sheets as "good—good," although the patches were then in place and leaks had already started. In a word, poor work in the locomotive repair shop was passed by careless or dishonest inspection, with the result that one innocent man was killed and another severely injured.

The same condition of bad repair work and bad inspection is illustrated by another report of the Interstate Commerce Commission, although, fortunately, no one was killed this time. In this case an exceptionally large number of flue pockets were applied in the front tube-sheet for the purpose of closing holes from which flues had been removed when changes in the firebox sheet were made. These were held in place by friction alone, no attempt having been made to prosser them or provide other positive means of holding them in place. As might have been expected, a flue pocket blew out of the front tube sheet, with the result that the escaping steam and water from the boiler caused the flames and firebox gases to be blown back into the cab with serious injury to the fireman and engineer. It should have been evident both to the boiler repairman and to the inspectors that flue pockets held in place by friction only were not safe. Moreover, in this case, too many flue pockets were used, leaving a large area of unstayed surface.

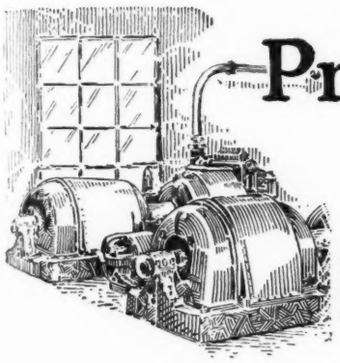
These incidents emphasize the importance of placing the repair and inspection of boilers in the hands of thoroughly trained men with a full appreciation of their responsibility for the safety of life and property.

Station Performance Here and Abroad

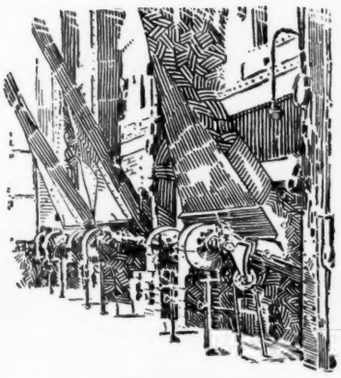
COMMENTING upon the growth of the electrical industry and the performance of certain power stations in England, the current issue of *The Power Engineer* (London) points out that in the report for the year ending March 31, 1923, the output of electric stations in that country increased seventeen and one-half per cent at an increased total coal consumption of only three per cent. Expressed in terms of performance, the average coal consumption per kilowatt-hour for the steam stations decreased from 3.11 pounds to 2.78 pounds, representing a betterment of over ten per cent. The lowest individual station consumption reported was 1.73 pounds per kilowatt-hour at North Tees and the highest thermal efficiency was 17.8 per cent at Carville "B."

These figures form an interesting comparison with practice in this country, where the central-station output for 1922 showed an increase of 16.8 per cent over 1921 at an increase of slightly more than seven per cent in coal consumption. The corresponding decrease in average coal consumption per kilowatt-hour was from 2.73 to 2.52 pounds. The best individual plant performance was 1.51 pounds per kilowatt-hour and a thermal efficiency of 17.77 per cent.

It will be seen from the foregoing comparison that, although the average performance is somewhat better in this country than in England, that country has made relatively greater improvement in performance during the period mentioned, and as for the best performance there is little to choose between the records in either country. The figures do show, however, that practice is striving toward the same goal on both sides of the Atlantic.



Practical Ideas *from* Practical Men



Blowing Dust from Motor While in Operation Causes Shutdown

An incident that occurred at our power plant some time ago may be of interest to *Power* readers.

Our installation consists of four 6,000-sq.ft. boilers fired by underfeed stokers. Air for combustion is supplied by a 50 hp. motor-driven forced-draft fan operated practically continuously and by a small vertical engine-driven fan. Both units are on the boiler-room floor and draw their air from the boiler room. Owing to the dust that is usually present in the room from the fine coal used on the stokers and from ash handling, it is necessary to shut the motor down about once a week and blow it out with an air jet. Quite recently it was necessary to overhaul the vertical engine on the standby unit, and after it was disassembled it was found necessary to order some new parts from the manufacturer.

During the time the engine was under repair, special attention was given to the motor-driven fan by the man who was responsible for keeping it clean and in operation. As an extra precaution he undertook to blow the dust out of the motor while it was running, but no sooner had the air been turned on than, much to his surprise, the circuit breaker opened and the motor stopped almost instantly. Upon closing the breaker again it was found that the motor would not turn and could not even be turned by hand. Upon further investigation it was seen that the dust had been blown into the clearance between rotor and stator and combining with the oil that had accumulated from the bearings, had wedged the rotor, preventing it from turning.

An attempt was made to free the rotor with a thin strip of metal but without success, so the motor had to be taken apart and thoroughly cleaned, which took about three hours, during which time the plant was shut down.

While this case is somewhat unusual, it tends to show how simply and unexpectedly interruptions are sometimes brought about. G. A. TAYLOR.

Boston, Mass.

Time-Saving Devices for the Gas-Engine Power Plant

The exhaust-valve seat of the general type of single-acting horizontal gas engine is located directly in the cylinder head or valve box in order to make this casting not too complicated. Taking out the valve is somewhat difficult, and often a second man is needed to hold the valve stem in a fixed position when compressing the spring in order to release the valve-spring disk.

One engineer constructed the instrument illustrated in Fig. 1. Lifting the valve and spring disk simultaneously is prevented by removing the inlet-valve cage and inserting a block of wood between the inlet-valve cage and the exhaust valve. After tightening the nuts on the valve bonnet studs, the tool is placed between the cylinder head and engine-room floor in the position indicated in Fig. 1, the top of the short piece of pipe *A* resting against the spring disk.

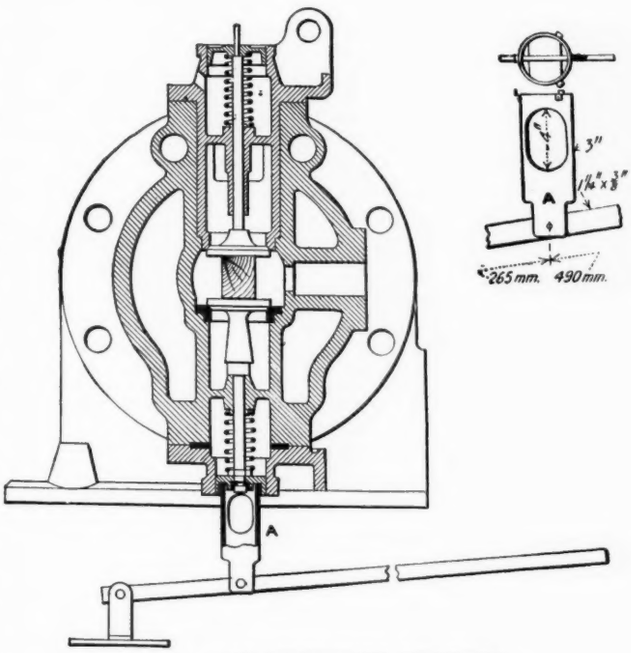


FIG. 1—VALVE-SPRING REMOVER

The other end of the pipe is flattened and split in order to fit the bar. Some play is allowed, and the pipe always will keep a vertical position, no matter how high the bar is raised. After raising the bar as high as possible, the device is held in position by means of a few blocks of wood inserted between the bar and the floor. The split collar that supports the spring disk is now easily accessible. The spring seat and disk being released, the exhaust valve can be withdrawn and cleaned as usual. When reassembling the different parts, the same procedure is followed, although it is necessary to "glue" the two halves of the disk collar to the recessed part of the valve stem by means of some belt dressing before lowering the bar.

Scraping the combustion chamber of a large hori-

zontal gas engine is an awkward job if the piston has to be pulled in order to get at the place where an excess of carbon has accumulated. A radical solution of this scraping problem is embodied in the rotary scraper

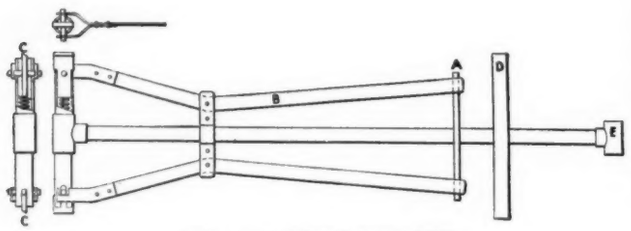


FIG. 2—CARBON SCRAPER

shown in Fig. 2. If the sleeved strip *A*, which is made of 2x$\frac{3}{8}$-in. iron, is moved to the left, the short arms of the 1x$\frac{1}{4}$-in. hoop-iron levers *B*, and the wrought-iron scraper blades *C* are moved inwardly against the tension of a spring. The device is now ready to be pushed into the cylinder barrel. After fixing the wooden guide *D*, the strip *A* is pulled back in order to release the scraper blades. After inserting a handle in the $\frac{3}{4}$-in. tee *E*, the scraper is revolved, and the carbon at the circumference of the head end of the cylinder barrel is removed. Cleaning the cylinder head is easily accomplished by means of a common hand scraper, although a specially shaped blade may be fastened to the front side of the rotary scraper.

If the shape or size of the cylinder head is such as to produce a groove at the end of the cylinder barrel, a special set of blades should be made to remove the carbon collected therein

H. WIELAND LOS.

Schoonhoven, Holland.

Shrink-Fitting a Heavy Shaft Assembly

When installing the equipment for the hydro-electric plant of the Andhra Valley Power Supply Co., near Bombay, India, G. V. Foulds, Field Engineer for the Pelton Waterwheel Co., developed a novel method of assembling shaft, rotor and waterwheel runner. For the particular conditions of the job this method proved much superior to the conventional press fit.

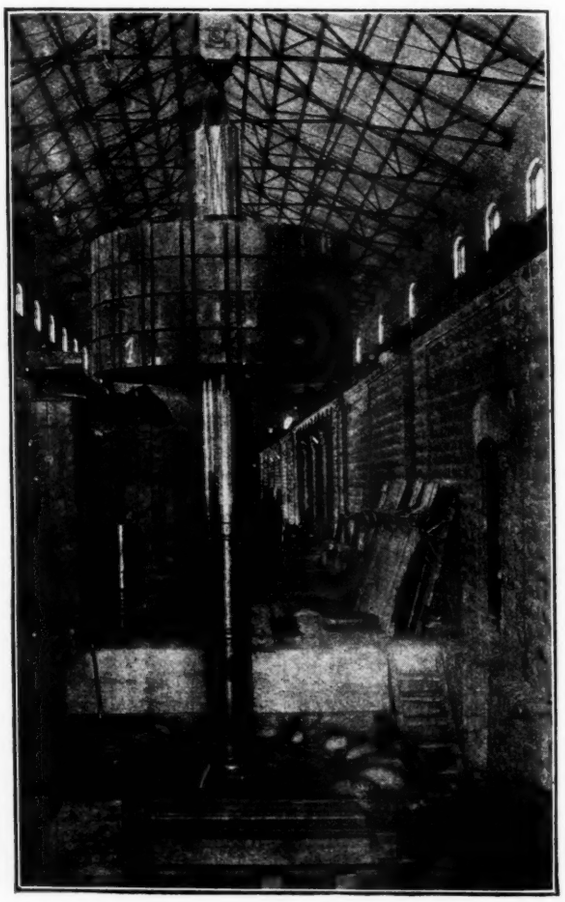
The plant comprises six 10,000-kva. generators, each driven by a single overhung impulse turbine. Each shaft assembly comprised four rotor spiders weighing eight tons apiece, the waterwheel runner weighing twelve tons, and the shaft itself weighing nine tons, a total of fifty-three tons. The bore of the runner and spider hubs was 0.003 in. smaller than the shaft diameter, which was 22 inches.

Largely on account of the lack of skilled labor it was decided to heat the spiders and runner by steam and shrink them on rather than employ the usual press-fitting methods.

A "steam box" large enough for one of the rotor spiders was constructed and a spider lowered into it. Steam was then supplied by a 1-in. pipe from a donkey boiler outside the building. Four or five hours of steaming was required, which increased the diameter of the bore from 0.003 in. less than the shaft to 0.012 in. more. Further steaming made only a slight additional increase, the time allowed being apparently sufficient to bring the spider up to approximately the temperature of the steam.

The first spider to be applied was the one next to the outboard bearing, so that in up-ending the shaft for insertion, it was necessary to grip it by a friction clamp over the journal itself, as there was no collar to keep the clamp from slipping off. The clamp used was composed of two 12x12-in. teak timbers fitted to the curvature of the journal and held together by two pieces of 12-in. I-beam 3 ft. long, with three 1$\frac{1}{2}$-in. bolts at each end. Forged links of 1$\frac{1}{2}$-in. steel were looped over the double hook of the crane.

To guard against looseness in the main key and to insure alignment of the pole slots of the four spiders, a long key with one end tapered was made to fit the slots exactly, and as each pair of spiders came together it was inserted and left in place until the last spider to be added had cooled and gripped the shaft. The time of cooling was prolonged as much as possible, twelve hours being usually allowed for it, although the hub began to grip the shaft after one hour.



SHAFT SUSPENDED FROM CLAMPS AND ABOUT TO BE LOWERED INTO THE STEAM BOX FOR THE FIRST SPIDER

Aside from the cleaning and preparation of hubs and shaft the actual work for each hub required one man for eight hours to tend the boiler, and the crane and four men for two hours to make the insertion and later to withdraw the assembly and place another spider in the box. The same procedure was followed for the turbine runner except that a slightly larger steam box was required and seven hours' steaming instead of five.

San Francisco, Calif. A. T. PARSONS.

Comments from Readers

Dual-Clearance Unaflow Engine

In *Power*, Sept. 25, 1923, Benjamin T. Allen states that "the use of the dual-clearance principle permits a possible reduction of from 60 to 75 per cent in the clearance volume required in unaflow engines when operating non-condensing, and avoids the counterflow action of the exhaust." This is good so far as it goes, but it does not go far enough, as in the engine referred to in *Power*, July 17, while the clearance volume is 5 per cent condensing it is 12 per cent non-condensing. To reduce the usual clearance volume 16 per cent is a great achievement, but I do not think that anyone would claim that a single-cylinder engine with 12 per cent clearance volume could possibly reach the higher flights of economical working.

As a matter of fact a less clearance volume can be obtained with an ordinary slide valve. A poppet valve, if properly constructed, would reduce the 12 per cent clearance by about two-thirds. The preceding remarks should be a sufficient reason for asking, Of what service is the duel clearance? as well as to show that the engine is not nearly so well suited for non-condensing as for condensing operation. If indicator diagrams taken from a unaflow engine doing the same duty as the dual-clearance engine and working under the same conditions, but operating with from 4 to 5 per cent clearance and fitted with auxiliary exhaust valves properly located, were superimposed on non-condensing dual-clearance diagrams, the loss of area in the latter during the compression period and the increase in area during the expansion period would clearly demonstrate which engine was the more economical. Unaflow engines with small clearance volume and using auxiliary exhaust valves properly located do give a very low steam consumption when working non-condensing as well as when working condensing, and nothing less than the results of an actual test would convince me that the dual-clearance unaflow can even approach their performance.

Further, so far from there being any gain from using the dual-clearance pipe, it seems to me there will be a loss, as the pressure in the dual-clearance pipe at the instant of release will always be less than the pressure in the other end of the cylinder at that instant. This means that instead of the steam flowing into the cylinder and helping to push the piston, the flow is in the opposite direction and as this is counterflow and directly through the main steam port, the results must be highly detrimental. In addition to this, after the piston has started on its return stroke, another counterflow action takes place, again washing the hot end of the cylinder with cold steam. In all there are three counterflow currents washing the steam-jacketed heads at every stroke. If this can possibly improve the economy, it is surely contrary to all theory and practice.

Regarding the piston type of valve, it is notorious for passing steam, and although in the engine in question the live steam cannot pass directly to the exhaust, it can readily pass from the high-pressure side to the low-pressure side, which is pretty nearly the same thing. A shaft governor controlling a piston valve soon fails to hold the engine to its speed when running light with the throttle wide open. This is due to steam passing the valve. One of the ablest of European steam-engine builders, a personal friend of the writer, has stated that the piston valve was "the refuge of the destitute." This may be a strong statement, nevertheless while a piston valve is good enough in a compound or triple engine to give direction to the flow of the steam, it is a poor substitute for a flat slide or a poppet valve in a single-cylinder engine.

El Segundo, Calif. DUNCAN A. MORTON.

Poppet-Valve Engines in America

In the Sept. 25 issue of *Power*, W. H. Odell states that poppet-valve engines were in use in the United States previous to 1865. Mr. Odell is correct.

In September, 1894, I rode on the sidewheel steamer "Louise" on Chesapeake Bay. Mr. Hudson, who was chief engineer of the boat, informed me that he bought the "Louise" 38 years before and had been chief on her ever since. That would mean that the boat was put in service in 1856. The engine was simple condensing with cylinder about 54 in. in diameter by 14-ft. stroke, and was fitted with poppet valves. It was the only marine engine I ever saw that was fitted with releasing gear and vacuum dashpots, and the old machine ran wonderfully smooth. C. S. GREEN.

Cleveland, Ohio.

I should like to add to the discussion that has already taken place on the early types of Corliss valve gears and as to the advent of the poppet-valve engines in America.

I began working in a machine shop at Plattsburg, N. Y., in 1853, and was there until 1858. About 1856 there came to the shop for scrap two engines, built I suppose, in England and taken out of Canadian boats that had seen many years of service on the St. Lawrence River and the Great Lakes. These engines had poppet admission valves, my attention being particularly called to them because my father, who was foreman of the shop, caught from them "poppet valve on the brain," which clung to him for several years thereafter. The claim that this type of valve was first used by the Sulzer Brothers is therefore far out of the way.

Not later than 1855, on an excursion across the lake to Burlington, Vt., I was in a large building on the lake front which housed a number of different industries and the power for which was supplied by one of the earliest Corliss engines with the typical valve release, the backward turning crankshaft—as we thought it then—the novel engine frame, etc. This distinctly antedates the early Corliss engine shown on page 545 of the Oct. 2 issue.

Another curiosity of that olden time was a twin-

screw boat, the "James H. Hooker," a large tugboat that carried freight and made regular trips through Lake Champlain. I knew this boat as early as 1851, when I lived at Whitehall, at the head of the lake. There was one large vertical low-pressure steam cylinder, the piston rod carrying a long, stiff crosshead extending over the cylinder on each side, with connecting rods reaching down to the two cranks. To keep the two cranks in constant balanced relation to each other, the shafts were connected by gears. A single gear on each shaft, the two meshing together, would have been all right, but gears of so large diameter were not permissible, so gears of a smaller diameter were used with two intermediates. This type of engine originated in England, and descriptions of it were published at that time. The boat ran satisfactorily for many years, but I have not known of any other in the United States.

Plainfield, N. J. FRANK RICHARDS.

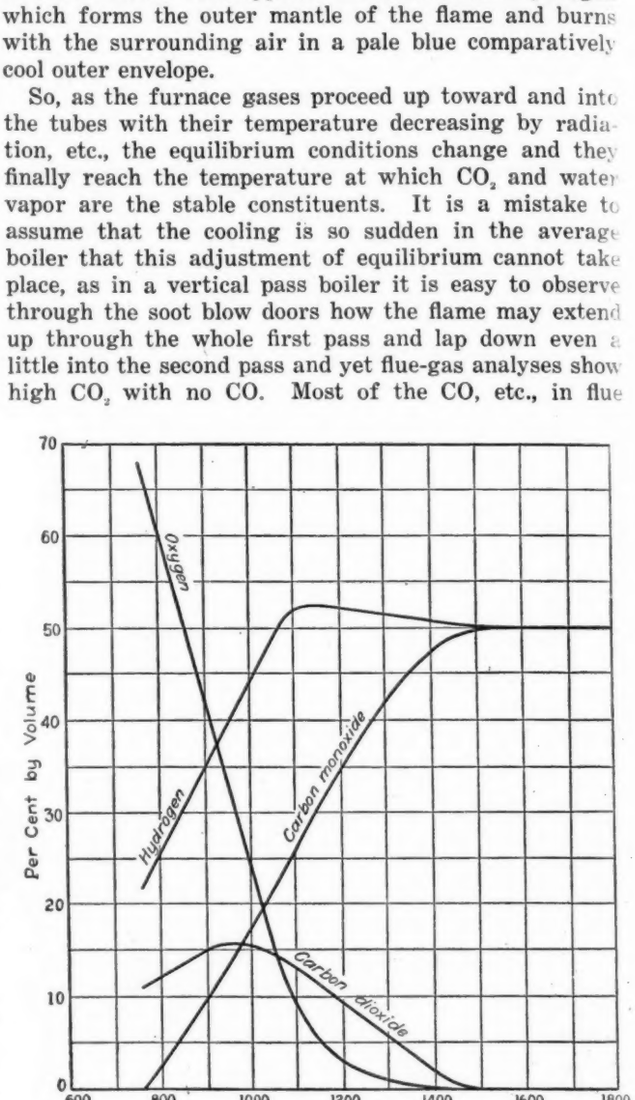
What Happens to Moisture When It Enters the Furnace?

Referring to Mr. McLaren's article, "What Happens to Moisture When It Enters the Furnace," *Power*, Sept. 18, I think his trouble is largely a confusion resulting from the attempt to transfer constants applicable to one set of conditions to other sets of conditions where they do not apply.

Most of the "authorities" quoted are, like the writer, retailers of scientific data, so if Mr. McLaren wants to get back to the real sources, he should consult books like Walker's "Elements of Physical Chemistry" or Mellor's "Chemical Statics and Dynamics." The latter discusses very fully the various theories of oxidation, of which combustion is one specific case, and goes fully into the effect of water vapor on the combustion of carbon monoxide, which cannot take place in its absence.

The scientific idea of the process of combustion seems to be that in gases, particularly at high temperature as in a furnace, the molecules break up into ions, which are atoms or groups of atoms carrying an electric charge, and that these ions have tendencies toward combination, relatively stronger in some cases than in others, but influenced also by the amount of the different substances present. As a result of the balance of these different tendencies, assuming reasonably uniform mixture and for a time constant conditions in the furnace, there will be formed certain percentages of CO_2, CO, H_2, O_2, N_2, etc., in the gases leaving the fuel bed, corresponding to the air supply; conditions and temperature of the fuel bed, etc., which will be different for each variation of these conditions, but which would be reproduced if the conditions returned to their former conditions, depending as they do on perfectly definite laws. These laws are not necessarily straight-line laws; that is, if the affinity of two atoms, or ions, *A* and *B*, is twice as strong as that of *A* and *C*, at 1,000 deg. F. it will not necessarily be, say, 220 per cent stronger at 1,200 deg. F. and 240 per cent (or any other percentages that may be assumed) stronger at 1,400 deg. C., as it may increase for a time and then decrease to less than its original value or even reverse. For instance, acetylene burning in air at ordinary temperatures form water vapor and CO_2, and if there is a deficiency of oxygen the excess fuel appears as uncombined carbon in the form of soot, but at welding-flame temperatures, which are operated with a theoretical deficiency of oxygen, the combustion is to carbon monoxide and the excess fuel appears as uncombined hydrogen which forms the outer mantle of the flame and burns with the surrounding air in a pale blue comparatively cool outer envelope.

So, as the furnace gases proceed up toward and into the tubes with their temperature decreasing by radiation, etc., the equilibrium conditions change and they finally reach the temperature at which CO_2 and water vapor are the stable constituents. It is a mistake to assume that the cooling is so sudden in the average boiler that this adjustment of equilibrium cannot take place, as in a vertical pass boiler it is easy to observe through the soot blow doors how the flame may extend up through the whole first pass and lap down even a little into the second pass and yet flue-gas analyses show high CO_2 with no CO. Most of the CO, etc., in flue



CURVES SHOWING COMPLETE DECOMPOSITION OF STEAM BY CARBON

gases, where there is a reasonable percentage of oxygen, usually blamed on sudden cooling to below ignition temperature, is really due to stratification of gases in the furnace and insufficient volume for proper mixture to obtain complete combustion, as once the gases have entered the tubes, they are pretty well confined to paths through the tubes and prevented from generally mixing. Evidence of this is the occasional secondary combustion between first and second passes and around superheaters of vertically baffled boilers, which occurs when a streak of gas high in CO mixes with a streak high in oxygen as the usual temperature of 1,000 to 1,200 deg. F. at the top of the first pass is usually ample for ignition. How stratification carries right through certain types of water-tube boilers in spite of open spaces and turns between passes, was observed by analyses taken across the width of the top of the third pass, the boiler being fired with a V-type overfeed stoker. Near the wall, low CO_2 was found due to air leakage through the brickwork, over the main combustion zone considerably higher CO_2 was found, in the center over the clinker bar the CO_2 fell away off owing to thin fire and rose again

over the other combustion zone. Analyses taken at about one-third way across seemed to check fairly well with the completely mixed samples in the breeching.

Owing to this difference in relative tendency of ions to combine at different temperatures and also to experimental difficulties of determining ignition temperatures which are affected not only by the percentages of the active gases present, but also by the amount of neutral gases, impurities such as dust, and by the pressure, the published figures for ignition temperatures of hydrogen and carbon cannot be taken as a measure of their relative affinity for oxygen. Besides, the temperatures cited for carbon from bituminous and anthracite coals are most likely influenced by hydrocarbons present, and it is known from the phenomena of spontaneous combustion that these may materially reduce the ignition temperature.

Another of Mr. McLaren's difficulties seems to arise from a confusion of the dissociation of steam by heat only, to which Dugald Clerk and the statement of *Power* for Dec. 14, 1920, refer, in which cases the word dissociation is properly used, and the decomposition of steam by the action of heated carbon, to which the statement of R. E. Millar, *Power*, Jan. 4, 1921, refers, as this is a well-known commercial method of making hydrogen, which is definitely stated in the other references.

The first of these is a purely physical phenomena and occurs only to a slight extent at boiler-furnace temperatures, according to the authorities quoted. The second is a chemical phenomenon and more complex, the relative quantity of the substances present also entering into the action. The curve, copied from Juptner's "Lehrbuch der Technischen Energien," shows the varying percentages of steam decomposed and the products formed where the steam is kept in contact with the heated carbon long enough for every ion to have a chance to combine, which is only approximated in a boiler furnace with the rapid passage of gases through the fuel bed, and this chiefly in the case of the underfeed stokers, as with the overfeed stokers and hand firing it seems more likely that the moisture will be evaporated off while the coal is at a comparatively low temperature and have little chance to come in contact with carbon at high temperatures. It will be observed that at the lower temperatures much of the steam is not decomposed at all and for what is, the main effect on the carbon is to form CO_2, whereas at the higher temperatures much more of it is decomposed with the formation of increasing quantities of CO. Considering the relatively small quantity of hydrogen existing in the coal in the form of either moisture or water of combination as compared with that in the hydrocarbons, it seems fully as reasonable that the occasional small quantities of hydrogen found in flue gas under exceptional circumstances arise from the decomposition of the hydrocarbons by heat as is known to occur to a considerable extent in the manufacture of coal gas.

The curve refers entirely to conditions in the fuel bed where an enormous excess of heated carbon is present, and as soon as the gases leave the fuel bed, conditions are entirely different, and the oxygen which has come through the thinner places of the fire and is introduced above the fuel bed is combining with the combustible gases as rapidly as mixture occurs and will continue to do so down to about 900 deg. F., by which time the gases have passed almost halfway through the boiler.

The greater the fraction of the fuel that can be consumed directly on the grates, the less will be the furnace volume required to insure complete combustion or, for a given furnace volume, the more complete mixture and thorough consumption of the last traces of combustible gases that will be obtained, so that it would seem that Mr. Hays' statement as to the advantage of moisture in increasing the volume of combustible gases evolved from the fuel bed is rather illogical. It is hard to see how there is any selective action in the hydrogen and CO formed from water vapor by which they will form a special flame for the ignition of the other unidentified combustible gases, so that it would appear that Mr. Myers' view of moisture as a diluent of the gases of combustion, and therefore a disadvantage, is the more reasonable.

The worst feature of the moisture in fuel is that it is usually paid for at the full price per ton, and I trust that the foregoing will in a measure at least show Mr. McLaren that the science of combustion is not in such bad shape as he fears and that scientific data do have quite reasonable relation to our every-day boiler-room occurrences.

H. D. FISHER.

New Haven, Conn.

Pump Pounds from Too Much Suction Lift

In the Sept. 18 issue P. C. H. inquires as to the cause of pounding in a 6x4x6-in. duplex pump having a 16-ft. lift and with the foot valve two feet below the surface of the water. Theoretically, the answer given is very good, as it is always desirable to place the pumps as near the level of the water supply as is convenient. But I have operated pumps of larger capacity with 16-ft. lift and also a 6x4x6-in. pump with a 20-ft. lift and had no trouble. I have, however, had trouble with duplex pumps pounding at each end of the stroke where the water flowed to the pump by gravity, owing to several causes such as the suction pipe becoming choked up, suction valve closing due to the pulsations of the water, pieces of packing catching in the suction or discharge valve seats preventing the valves from seating tightly and putting the weight of the water on the foot valve. The trouble P. C. H. speaks of may be caused by worn valves or the valves may not seat tightly or only intermittently, which would cause pounding at the end of the stroke and on the foot valve. Another frequent cause is too much lost motion on the links and pins connecting the steam valves. When this wear becomes excessive, it allows the pistons to travel too far on each end and cause pounding.

I would suggest that he thoroughly overhaul the pump and renew any packing or valves necessary. It may be necessary to face up the suction and discharge valves and refit them to the seats. New valves can be put in, but the seats must be faced up to allow them to fit tightly. If a number of valve springs have become weak, the pump may pound on all four strokes. Also, if the check valve in the feed line near the boiler leaks badly or does not seat tightly, it will cause the pressure to fall on the discharge valves of the pump, make them wear out quickly and cause the trouble P. C. H. speaks of.

If the pump is in good operating condition, it should work satisfactorily with a 16-ft. lift or even with a 20-ft. lift. In any case it should not be necessary to lower the pump as suggested in the answer given.

Cambridge, Mass. R. A. CULTRA.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Length of Pump Cylinders

In direct-acting steam pumps why are the cylinders of the water ends made so much longer than those of the steam ends? W. L. G.

The water cylinders need to be longer than the steam cylinders, to give ample space for the water passages without obstruction by the water pistons when the steam pistons are at either end of their stroke, and also to obtain latitude in construction and assemblage of the piston rods.

Freezing and Frosting of Pneumatic Tools

What causes compressed-air tools to become frosted or obstructed with ice? B. F.

When the air is compressed by work performed in the compressor, the work energy is converted into heat which is imparted to the air, raising its temperature. The heat is absorbed by intercooling or by radiation from the receiver and pipe lines, and when the air enters the air tool, it usually is at atmospheric temperature. Upon being re-expanded in air tools, or re-expanding when exhausted to the atmosphere, the work of expansion is performed at the expense of internal heat in the air, and the temperature drops below that of the atmosphere. When the conditions are such that the temperature falls below 32 deg. F. within the pneumatic tool, and the air contains moisture, the moisture becomes frozen, forming ice within the machine, or the frozen moisture is expelled with the exhaust like snow. When expelled as perfectly dry air, the exhaust nozzle may become chilled sufficiently to become frosted from freezing of moisture deposited by the surrounding atmosphere, or the temperature of the air exhausted into the atmosphere may be low enough to freeze moisture of the atmosphere into which the exhaust is discharged.

Breakage of Connecting-Rod Wedge Bolt

We have been troubled with breaking of the top wedge bolt for adjustment of the crankpin brasses of the connecting rod of our Corliss engine. The connecting rod has a solid end with a bolt in the upper and lower ends of the adjustable wedge. The top bolt has broken several times just under the head and once or twice about where it enters the wedge. What is the remedy for the trouble? S. P.

Such breakages result from extraordinary tensile and bending stresses that arise from continual pounding due to necessary clearance between the brasses and crankpin tending to drive the wedge downward from leaving clearance between the brasses; from improper alignment of the bolt and a rocking motion of the wedge due to poor fitting of the bearing of the wedge in the end of the connecting rod; poor fitting of the top and bottom bearings of the brasses in the mortise of the connecting rod; and from attempting to adjust the crankpin bearing without first fitting the brasses together.

The first precaution against breakage of the wedge bolts is to provide the connecting rod with accurately machined surfaces of the mortise and wedge and have tops and bottoms of the brasses parallel with a snug fit in the rod so there will be no rocking motion to turn the wedge around one of its corners. The bolt hole in the rod should be large enough to preclude any possibility of the sides of the bolt touching the rod. The bolt should have a fillet under the head and the hole in the rod should be countersunk to clear this fillet. The brasses should be fitted or shimmed apart to leave only enough clearance for cool running of the crankpin when they are firmly held between the wedge and opposite side of the mortise in the connecting rod, remembering that the office of the wedge is simply to hold the brasses together and not to adjust their distance apart. With only necessary clearance for the crankpin there will be some jarring, tending to turn or drive out the wedge, although it may not be heard loud enough to be called a pound, but the tendency to disturb the wedge and cause extraordinary stresses will be less the better the all around fitting, particularly of the brasses.

Operating Engine with Motor Floating on Line

For driving a wood-turning mill we are operating a reciprocating engine for which the maximum load is 150 hp. delivered to a lineshaft running 310 r.p.m. Mill refuse is used for generating steam, but when there is a shortage of fuel, the engine receiving shaft is disconnected from the line shaft by throwing out a clutch and the line is driven by a 150-hp. induction motor connected by a chain drive and supplied with current from a central station. We are to have an additional load of about 50 hp. What is the objection to operating the engine and motor in parallel to cover the temporary load? G. N. S.

The only objection would be that when the mill is operated with less than full load, the engine probably would carry the motor to a speed that would pump back current to the central station system. This would be a drag on the engine varying from 0 at normal speed to about full load of the motor for an increase of about 5 per cent of speed above synchronous speed, with no mill load.

With the mill load one-half the full load for the engine, the speed would be lower and there would be less than half as much drag by the motor; and at full engine load the speed would be reduced to normal when there would

be no drag excepting the friction of the motor. Further increase of the load would be picked up by the motor with slightly reduced speed, later cutoff and a little more than full load for the engine. To prevent the engine from taking more than full load, the governor could be provided with a stop, to limit the length of cutoff to full load for the engine.

The only objection to operating the engine and motor thus in parallel would be the consumption of steam required for overcoming the drag of the motor when the mill load is less than full load for the engine. But this would occur only when there would be no requirement for power from the motor. If only temporary, the loss would be inconsiderable, as the cost for fuel when burning waste would be limited to the labor of firing. However, if there is a shortage of fuel, it might be necessary to reduce the speed of the engine slightly, thereby causing the motor to pick up power for less load on the engine.

Connections for Boiler-Feed Pipes

Why is a reinforcement or bushing required where feed-water lines enter a return-tubular boiler, but not for tapping in the water-column connections? E. H.

A feed pipe should be carried through the head or shell near the front end and discharge about three-fifths the length of a horizontal return-tubular boiler from the front end, and the connection through the head or shell should be made with a brass or steel bushing or flange for connecting the internal and external pipes, but with clearance between their ends, and arranged so that the removal of either pipe will not disturb the other.

Water-column connections, like other threaded openings, require flanges when the thickness of the boiler material is not sufficient to give the requisite number of screw threads for standard pipe tapping. Standard tappings for 1-in. to 2-in. pipe have 11½ threads per inch. For 1-in. and 1¼-in. pipe the minimum number of threads in the opening should be 4, which is obtainable with a minimum plate thickness of 0.348, or about $\frac{11}{32}$ in.; and for 1½- and 2-in. pipe the minimum number of threads in the opening should be 5, which is obtainable with a minimum plate thickness of 0.435, or about $\frac{7}{16}$ in. When the plate is not of sufficient thickness for obtaining the requisite number of screw threads, the opening should be reinforced by a pressed-steel, cast-steel or bronze-composition flange or plate so as to provide the required number of threads.

Heat Value of Coal of Stated Analysis

What would be the heat value of a bituminous coal whose ultimate analysis is: C = 62 per cent; H = 5 per cent; O = 15 per cent; S = 1 per cent; ash = 17 per cent? S.P.

Dulong's formula for computing the calorific value of fuels from the utlimate analysis is:

Calorific value (B.t.u. per lb.) = $14{,}600\ C + 62{,}100\left(H - \frac{O}{8}\right) + 4{,}000\ S$ in which C, H, O and S respectively represent the percentages of carbon, hydrogen, oxygen and sulphur present in the fuel. As $H - \frac{O}{8} = 0.05 - \frac{0.15}{8} = 0.05 - 0.019 = 0.031$, by substituting, the formula becomes,

B.t.u. per pound = $14{,}600 \times 0.62 + 62{,}100 \times 0.031 + 4{,}000 \times 0.01 = 11{,}017$ B.t.u.

Comparison of Valve Setting with Indicator Diagram

Recently, I applied an indicator to an old 28x60-in. Corliss engine running 70 r.p.m., boiler pressure 115 lb. gage, and the valves were adjusted until the diagram shown was obtained when the valves were checked with the following results:

Head-end admission valve with wristplate on center, $\frac{1}{8}$-in. lap; with engine on *H* center and valve gear hooked up in running position $\frac{5}{8}$-in. lead.

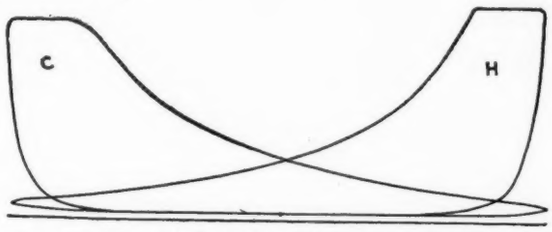
Head-end exhaust valve, wristplate on center, $\frac{1}{16}$-in. lap; with engine on *H* center and valve gear hooked up, $\frac{3}{4}$-in. lap.

Crank-end admission valve with wristplate on center, no lap; with engine on *C* center and valve gear hooked up in running position, $\frac{1}{8}$ in. lead.

Crank end exhaust valve with wristplate on center, $\frac{21}{32}$-in. lap; with engine on *C* center and valve gear hooked up, $1\frac{5}{16}$-in. lap.

How could this valve setting produce the diagrams shown? P. E.

The assumed central position for the wristplate could not have been the same when measuring the laps and leads of the steam valves, or the measurements, if



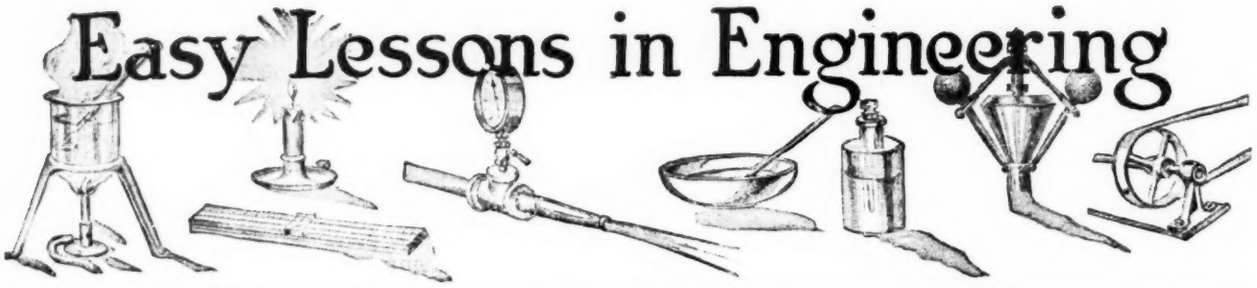
INDICATOR DIAGRAMS FROM 28" X 60" CORLISS ENGINE, 70 R.P.M.

correctly made, would have shown the steam lap plus lead of one end equal to the steam lap plus lead of the other end. If the engine were accurately placed on the *C* end dead center with the lead $\frac{1}{8} = \frac{22}{32}$ in. and turned backward without lost motion in the valve gear to zero lap, then, according to the measurements quoted, the *C* end exhaust lap would be reduced to $\frac{21}{32}$-in. lap, requiring movement of the valve = $1\frac{5}{16} - \frac{21}{32} = \frac{43}{32}$ in. But turning the engine backward from the *H* end dead center sufficiently to remove the $\frac{5}{8} = \frac{20}{32}$-in. lead would, according to the measurements, reduce the *H* end exhaust lap from $\frac{3}{4}$ in. to $\frac{1}{16}$ in. for a valve movement of $\frac{3}{4} - \frac{1}{16} = \frac{22}{32}$ in.; that is, $\frac{22}{32}$-in. movement of the *C* end steam valve would correspond with $\frac{21}{32}$-in. movement of the *C* end exhaust valve, but only $\frac{20}{32}$-in. movement of the *H* end steam valve would correspond with $\frac{22}{32}$-in. movement of the exhaust valve.

The greater lap of the *C* end exhaust valve should give considerably earlier compression on that end, but this does not appear to be verified by the diagrams. Undoubtedly, the discrepancies referred to result from inexactness in the measurements and the difficulty in placing such a large engine on dead centers. The diagrams are good and, when compared with the measurements quoted, afford good illustrations of the fact that the valve setting of an engine cannot be accurately determined without application of an indicator.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses.—Editor.]

Easy Lessons in Engineering



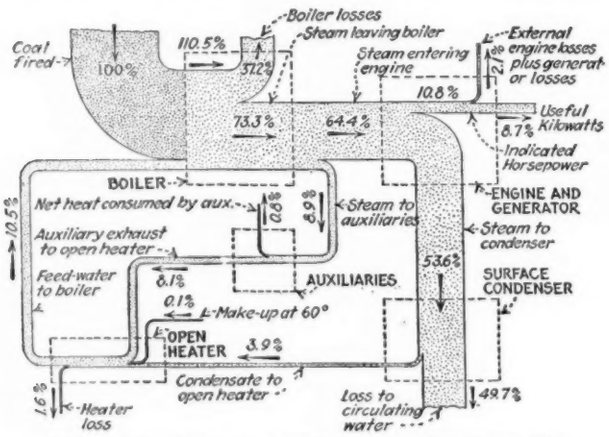
Heat Balance of a Power Plant

The purpose of the present article is to show by an actual example how a simple heat balance for a condensing steam plant may be worked out and represented by a diagram.

The final result is shown in the accompanying diagram, in which the flow of heat is represented by bands whose widths indicate the relative amounts of heat involved. Dotted rectangles are used to show the main groups of apparatus.

To simplify the heat balance, certain losses have been grouped. For example, all the boiler and furnace losses are combined, as are the generator and outside engine losses.

The boiler is fired with 13,400-B.t.u. coal and produces steam at 150 lb. gage and 100 deg. superheat.



SHOWS RELATIVE AMOUNTS OF HEAT INVOLVED

An open heater supplies feed water at 205 deg. Some of the steam goes to the auxiliaries, which exhaust to the open heater. The rest goes to the main engine, developing 428 i.hp. and 255 kw. The engine exhaust passes to a surface condenser, and the condensate at 105 deg. passes to the open heater, where it mixes with the condensed auxiliary exhaust and a small amount of makeup water.

Turning to the table, the weights shown in column *A* are determined as follows: 1 by weighing; 2 and 3 by flow meters; 4 as the difference between 2 and 3; 5 by estimation from size and water rate of auxiliaries; 6 assumed equal to 5; 8 by subtracting 5 from 3; 9 by computation from indicator cards; 10 from the switchboard wattmeter; 12 and 13 assumed equal to 8; 15 assumed equal to 4.

These figures obtained, the next step is to divide all items in column *A* by 750 (the weight of coal fired per hour) to get the weights per pound of coal fired, as shown in column *B*.

The next step is to figure the items in column *C*, which shows the heat flow corresponding to the items in *B*. Starting at the top and working down, the first item is the known heat value of the coal. Item 2 is the product of 8.10 by (205 — 32), which is the heat in one pound of water at 205 degrees.

The heat in one pound of steam at 165 lb. absolute and 100 deg. superheat is 1,252 B.t.u. This, multiplied by 7.85, gives item 3. To get item 4, add 13,400 and 1,401 to get 14,801 (the total boiler input) and subtract the useful output, 9,828.

Item 5 is the product of 0.95 by 1,252, the heat in one pound of boiler steam. To get item 6, assume that the auxiliary exhaust is dry saturated steam at atmospheric pressure, containing 1,150 B.t.u. per pound. Then 0.95 × 1,150 = 1,092 B.t.u. The difference between this and item 5 gives item 7.

Item 8 is 6.9 times 1,252. Item 9 is 2,545 (heat equivalent of a horsepower) multiplied by 0.57. Similarly, item 10 is the product of 0.34 by 3,412. Item 11 is the difference between items 9 and 10.

The heat per pound of the engine exhaust steam is not directly known, but item 12 may be taken as the difference between items 8 and 9. Item 13 is the product of 6.90 (105 — 32). Item 14 is the difference between items 12 and 13. Item 15 is the product of 0.25 by (60 — 32).

To get item 16, add items 6, 13 and 15 to get 1,603 (the total heater input) and subtract the useful output (item 2).

Column *D* is easily figured by noting that 13.4 is one per cent of the heat in the coal. Dividing the items in column *C* by 13.4 gives column *D*. These are then laid out graphically as shown in the diagram. Check each branch of the diagram by addition and subtraction. Where necessary the figures may be increased or decreased by 0.1 per cent to give an exact check.

HEAT—BALANCE DATA AND RESULTS

No.		A Lb. per Hour	B Lb. per Lb. of Coal	C B.t.u. per Lb. of Coal	D Per Cent of Heat in Coal
1	Coal fired	750	1.00	13,400	100.0
2	Feed water to boiler at 205 deg.	6,075	8.10	1,401	10.5
3	Steam leaving boiler at 150 lb. gage, 100 deg. sup.	5,890	7.85	9,828	73.3
4	Boiler losses	185	0.25	4,973	37.2
5	Steam to auxiliaries	713	0.95	1,189	8.9
6	Auxiliary exhaust to heater (assumed dry saturated at atmospheric press)	713	0.95	1,092	8.1
7	Net consumed by auxiliaries	.....	.....	97	0.8
8	Steam delivered to engine	5,177	6.90	8,639	64.4
9	Indicated horsepower of engine	428	0.57	1,451	10.8
10	Kilowatt output of generator	255	0.34	1,160	8.7
11	External engine losses plus generator losses	.....	.....	291	2.1
12	Exhaust steam to condenser	5,177	6.90	7,188	53.6
13	Condensate from condenser to heater at 105 deg.	5,177	6.90	504	3.9
14	Loss to circulating water	.....	.....	6,684	49.7
15	Makeup water to heater at 60 deg.	185	0.25	7	0.1
16	Loss from heater	.....	.....	202	1.6

The completed diagram gives a clear picture of the heat flow in the plant which can be studied with a view to improving operation.

Boiler-Feed-Water Circuits in Power Stations*

ON ACCOUNT of the stresses it must withstand, a boiler is necessarily built of material that is susceptible to corrosion. Moreover, the temperature and pressure conditions are such as to promote this action, while the coating of scale that would give some protection cannot be permitted for reasons of safety and efficiency. Therefore so far as the boiler is concerned, the only remedy is to make the water chemically inert.

Following the working fluid in its passage through the power-plant cycle, we next come to the superheater. Here the temperature conditions are still more severe, and it is here that the effect of acids due to inorganic salts and hydrocarbons in the boiler is particularly felt. In the superheater, as in the boiler, it is impracticable to use an acid-resisting material.

Coming next to the turbine, it is the writer's experience that pure steam at the highest velocity and temperature ordinarily encountered produces no bad effect on the blading. If, however, there is any foreign material in the steam, such as flakes of corroded material from the boilers, economizers and piping, or dry powders due to the priming of boilers containing alkaline feed water, the effect on the blading is bad.

Leaving the turbine, the working fluid passes at low temperature to the condenser, then through an extraction pump to the feed reservoir, and from there by feed pumps to the boiler, being regeneratively heated on the way by exhaust steam and low-temperature furnace gases. In a modern installation this cycle requires on the average only about six minutes from boiler back to boiler. This speed with which the working fluid passes through the plant cycle tends to reduce the actual amount of working fluid required for a given power capacity, but at the same time places a heavy premium on its purity and chemical inertness.

With water initially pure there are only three sources from which it can absorb impurities. These are: Condenser circulating water leaking into the system; the makeup water; air and other gases absorbed in the feed reservoir.

The contamination through the condenser is probably one of the most costly of operation defects. Where the circulating water is non-corrosive, this can be largely eliminated by careful packing and good workmanship and by avoiding temperature changes such as are caused by the admission of steam when the vacuum is not maintained. Corrosive circulating water presents a more difficult problem which may possibly be solved in the future by the use of tubes of pure nickel or nickel alloys. Solid tubes of such material have not hitherto been available, but I am able to state that extremely promising results have lately been achieved in the production of solid-drawn tubes of Monel metal. Should the present experiments result in the production of such tubes on a commercial scale, it should afford a complete solution of this trouble.

Coming next to the makeup feed supply, there can be no doubt that in modern high-pressure plants distilled water is essential. Fortunately, the cost of distillation need not be high, as it is possible so to insert the evaporators in the cycle of operation that full conservation of heat is obtained.

There are two possible methods of maintaining the working medium free from the dissolved gases that cause corrosion. One is to prevent the access of air at all points of the feed circuit and introduce the makeup feed into the condensers, where it will be automatically deaërated. The other is to allow the feed water free contact with air, but to deaërate it at a suitable point in the circuit before it has been put in the corrosive condition by the addition of heat. Both methods are workable, and each has its special field of application dependent on circumstances. The first method is known as the closed system.

Tracing the development of the closed system, consider first the simplest open feed circuit, shown diagrammatically in Fig. 1. Suppose we close this system and prevent access of air by connecting the water-extraction pump directly to the feed pump as shown in Fig. 2 (paying no attention to the parts shown in dotted lines). As far as air elimination is concerned this is ideal, but its inflexibility is such that it is entirely impracticable for ordinary power-plant use. Obviously, it is not practicable to keep the same amount of fluid flowing through all parts of the power circuit at the same time.

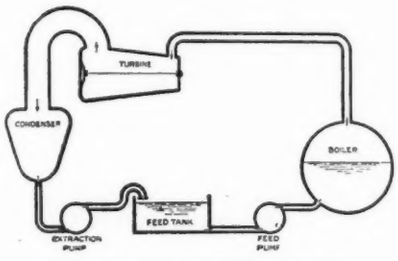


FIG. 1—OPEN FEED-WATER CIRCUIT

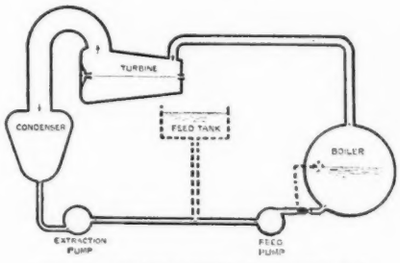


FIG. 2—IMPRACTICAL FORM OF CLOSED CIRCUIT

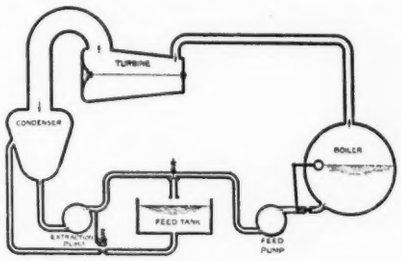


FIG. 3—PRACTICAL FORM OF CLOSED CIRCUIT

Having discarded the arrangement shown in Fig. 2, we might return to that of Fig. 1, placing a cover over the feed tank and sealing the space within by means of a steam jet. Suppose the cover is made airtight and enough steam is admitted to maintain a slight positive pressure on the water. At first sight this looks good, but it has a fatal defect. In the absence of air the steam would condense very rapidly, thus filling all the space and reducing the system, in effect, to that shown in Fig. 2, with an enlargement in the pipe between the extraction pump and the feed pump.

Suppose, now, the Fig. 2 arrangement is modified by adding the parts shown in dotted lines, the chief of these being the elevated feed tank or the surge tank. With this placed between the extraction pump and the feed pump and with the feed pump controlled to maintain a constant water level in the boiler, the extraction pump can take the condensate from the condenser as fast as necessary and the feed tank will take up the fluctuations. This is a partial solution, because the air-saturated water in the feed tank only gradually enters the circuit.

There is, however, a complete solution—that shown in Fig. 3. In this, the feed tank is external to the main circuit, but comes into action automatically as required. Here the delivery of water by the feed pump is determined solely by the boiler requirements, while the extraction pump, similarly, removes the condensate from the condenser without regard to the boiler requirements. Two automatic valves take care of the difference between the amount of extracted water and of that fed to the boiler. When the extracted water exceeds the feed-pump demand, the pressure rises in the middle section and a relief valve allows the excess to pass to the feed tank. When the opposite condition occurs, the fall of pressure in the central

*Abstract of paper recently presented by James G. Weir, of Glasgow, Scotland, before theh Koninklijke Institute Van Ingenieurs, (Holland).

section opens a valve permitting water to flow from the feed tank to the condenser, where it is automatically deaërated before passing farther into the cycle.

As distinguished from the systems just described, the deaëration system does not isolate the feed water from contact with the air, but abstracts the air from the water before it enters that portion of the circuit where it would otherwise cause active corrosion. In one of its simplest forms, commonly used on steamships, the feed water passes from the open feed tank through a spray valve into a chamber where it mixes with exhaust steam. The pressure in the chamber is maintained at the equivalent boiling point of the mixture by a small connection to the condenser, which also withdraws the liberated air.

A water level is maintained in the base of the chamber by means of a float which in the case of water-tube boilers controls the delivery of water from the feed tank into the chamber. As the water in the base of the steam heater is at the boiling temperature corresponding to the pressure, it is necessary that the steam heater should have a considerable static head over the feed pump for satisfactory operation.

Many successful installations based on this general principle are now in operation. One of the advantages of the deaëration system is the ease with which it can be applied to existing stations having open circuits.

A careful study of the feed circuit of any station will enable the heat balance to be more clearly appreciated. Regenerative principles can then be employed in connection with the furnace gases and exhaust steam to heat the air used for combustion and to heat the feed water so that it may be delivered to the boiler as near the boiler temperature as possible.

The very-high boiler pressures now employed are making steam heating in more than one stage practically essential for good economy. This calls for care in the design and construction of the high-pressure heaters. In these heaters freedom to expand and contract without distress is essential.

Feed Heater Virtually a Part of the Boiler

It should be noted that with high steam pressures and with feed heating to high temperatures, we are virtually making the feed heater a part of the boiler. The potential energy contained in a high-pressure steam heater approaches that of the boiler itself. To generate steam at 500 lb. pressure from condensate at 80 deg. F. with full regenerative steam heating requires an expenditure of 400 B.t.u. in steam heating and only 790 in evaporation. That is, fully one-third of the heat transfer is carried on outside the boiler. With the logical development of still higher pressures it is certain that the boiler proper, or steam-generating portion of the feed circuit, will be relatively restricted in size and capacity, and will contain only a very limited amount of water.

Similarly, in considering the conditions on the combustion side of the boiler circuit, we must alter our conception of the boiler as a self-contained unit, and we must now regard it as a chain of processes having a combustion chamber proper in which a carefully regulated chemical process is carried out, and a series of heat-exchange chambers in which the heat gradients are carefully adjusted to avoid unnecessary loss of heat availability.

In considering the steam circuit and functions of the working fluid in modern practice, it is evident that we are in a transmission stage of development. The two well-known methods of increasing the efficiency of any power plant are first to increase the temperature range of the cycle and, second, to absorb as much of the heat as possible at or near the highest temperature of the cycle and reject as much as possible at or near the lowest temperature. The latter idea is approached by way of regenerative systems of feed-water heating. As already indicated, the difficulties of practical steam heating have been solved and this method may now be fully exploited.

There still remains, however, the irreversible heat drop between the flue gases and the steam, which forms the basic source of inefficiency in the steam plant. For example, with a boiler operating at 250 lb. pressure and a potential absorption of heat at 3,560 deg. F. absolute, we are forced by the peculiar practical conditions in the normal boiler plant to absorb the bulk of that energy in the neighborhood of 860 deg. F. absolute. Although the range of temperature operating in the plant is roughly 3,000 deg. F., the actual practical range of working (excluding superheating conditions) is more nearly 330 deg., and 500 deg. with the best modern superheating practice. In the internal-combustion engine, on the other hand, we find that by a process analogous to feed heating in the steam cycle a portion of the energy is tapped from the original supply and is transmitted during the cycle, by the piston and moving parts of the engine, to the working fluid. This process we term compression, and its immediate effect, by raising the temperature of the working fluid, is to elevate the temperature at which energy is absorbed.

Assuming a compression temperature of 1,450 deg. F. absolute and an explosion temperature of 3,560 deg., the bulk of the heat is absorbed at, say, 2,500 deg., and the range of temperature is no less than 650.

The problem before the steam-power-plant designer is therefore clear. If we can use Diesel temperatures in steam practice, we shall achieve at least Diesel efficiency. The same broad principles apply to both cycles; the basic difference is in the working fluids.

It is the task, therefore, of the metallurgist and designer to achieve an engine of the external-combustion type in which, by means of a regenerative process or otherwise, the wasteful and theoretically unnecessary temperature loss between the furnace temperature and the steam temperature will be eliminated, so that the efficiency of the steam cycle may be raised to at least that of the Diesel cycle.

Obstacles in the Way of Water Power

In an address, "Harnessing the Country's Water Power," delivered before the Empire State Gas and Electric Association's convention held at Lake Placid Club, New York, Oct. 8, 1923, O. C. Merrill, executive secretary of the Federal Water Power Commission said in part:

There is need of harmonious action between the nation and the states, and between state and state, not only in matters of water-power development, but in the whole field of public-utility relations. Under the federal law 2,500,000 hp. are already built or building. You do not need to be told how little, outside of the reconstruction at Niagara, has been built or started in New York under that law or otherwise in the last three years, notwithstanding the fact that applications for millions of horsepower have been filed before your commission and ours affecting streams within this state or on its boundaries. While it is true that the major sites applied for are on an international stream, requiring an international agreement before development can proceed, a situation that would of itself mean delay, the problem is unnecessarily complicated by the lack of any fixed state policy respecting the development of its water powers, and until such a policy has been established no development of consequence can be expected. The determination of such a policy is a responsibility of the people of this state.

Differences of opinion have arisen between the State of New York and the Federal Power Commission respecting the ultimate limit of the authority of the state and of the nation over navigable waters and in international streams. The Commission has certain views of its own powers in the premises, as has also the State of New York. It happens that the respective powers thus viewed overlap to a certain degree. But the possession of a power and its exercise are quite different matters. The Commission's unquestioned duties are of such magnitude that it would not be inclined to assume others which the states have the authority and the disposition to perform, even if the letter and spirit of the Federal Water-Power Act did not call for co-operative rather than independent action. There are no differences of opinion between the Commission and the State of New York which need be an obstacle in the consideration of any particular case or which would justify the failure of either to co-operate with the other, if the state had a settled policy and was ready to proceed.

New York, however, is not the only state with an un-

settled policy. Arizona presented to the Federal Power Commission only a few days ago a proposed new policy diametrically opposed to what it has hitherto pursued, a policy having no apparent hope of success, but serving to delay her own development and to prolong her conflict with her neighbors. California, with electric systems among the best equipped, best managed and best regulated in the United States, and with the cheapest and most abundant energy supply, went through an expensive campaign only a few months ago to defeat the proposals of those who would reverse the established policy and risk the wrecking of existing systems that they might embark the state on the troubled seas of political ownership. Other similar examples might also be cited.

These divergent views and unsettled policies have reference almost exclusively to water-power development, for water powers are generally still subject to some form of public control, and they occupy a peculiar status in the public mind. They are deemed a natural resource, and there is fear lest they escape from public ownership and control. That water powers are a natural resource, and that whenever owned or controlled by public agencies that ownership and control should be permanently retained, is a fundamental principle of the federal policy. It should be equally a principle of state policy to the full extent that the states have ownership or control, either concurrently with or independently of the federal government. It is a principle, furthermore, to which you gentlemen of the industry should freely subscribe. All that you need ask is that the control be intelligently exercised.

The principle that values inherent in a public resource developed and used in the performance of an essential public service, by an agency created by law for that purpose, shall not be capitalized in excess of amounts actually expended in acquisition, is likewise a fundamental feature of the federal policy, applicable in all cases where power sites are licensed under the federal law. Whether our water powers have great values or not, the public fear that their values will be capitalized at the expense of the rate payer is groundless as far as sites under federal ownership or control are concerned, and these sites involve 85 per cent of the total water powers of the United States. This provision of the federal law is not hindering in any degree the financing and construction of water powers under federal control, and a similar provision would not hinder the development of the remaining 15 per cent subject to exclusive state control. This is a policy on which all, the utilities included, can well agree and thus remove it from the field of controversy.

There are other problems which must also be met and solved. We must first of all make it clear that we are dealing with a program far wider than the territory or the authority of any individual state and yet of vital interest to the citizens of each state. We must harmonize these interests, while at the same time developing a policy and accomplishing a program which will be to the common interests of them all. This will require co-operative action and reasonable uniformity of legislation. There must be no state barriers against the interchange of energy and no type of development that cannot become an integral operating part of the combined system.

If we are to accomplish our purpose, we must have ourselves a positive program around which we may rally all those who are honestly seeking development in the common public interest. With respect to water power, the principles of the federal policy as contained in the Federal Water-Power Act may well form the basis of such a program. I do not suggest this just because it is a federal policy, but because it is a policy that has been tested by experience and that is producing results. Capital has no difficulty in meeting the terms of the law and its provisions afford protection to every legitimate public interest. With state legislation and state policy in reasonable conformity with federal law and policy and with that full co-operation between state and nation, which it is the purpose of the Federal Power Commission to promote and maintain, the obstacles now existing to water-power development would disappear.

Deterioration of Turbine Oils in Use*

By Alexander Duckham, F.C.S., M.I.P.T., and Stanley E. Bowrey, B.Sc., F.C.S.

Oxidation products play an important part in the formation of oil-water emulsions and their separation. In one case the time for separating out of oil and water was increased from eight minutes to about five hours by oxidation of the oil.

TURBINE construction has now reached such a high standard of excellence that the lubrication of the main bearings approaches the ideal more nearly than in any other lubricating problem commonly met with. Fluid friction is diminished by the use of thin oils, and metallic contact is absolutely prevented by an efficient forced-feed system. In consequence many turbine bearings run for years at high speed without exhibiting any appreciable sign of wear. The principal source of trouble lies in the tendency for condensed steam from the glands, or water from the cooling system, to find its way into the oil in quantities large enough to hinder the proper functioning of the oil. The problem, therefore, is to secure oil that will separate readily from water and will retain this property during the long period of use, thus enabling the water to be drawn off at intervals instead of being suspended in the oil and circulated to the bearings.

In some instances turbines are run on what is in fact an emulsion of oil and water, and it is found that so long as the amount of water does not exceed a certain proportion, which may be as high as 15 or 20 per cent of the oil, no trouble is experienced. The principal risk involved lies in the possibility of water settling out to an extent sufficient to cause the pump to draw water only. This is most likely to occur after the machine has been standing, and, consequently, the accepted practice is to drain all separated water from the sump immediately before starting, although where a large settling tank is provided the possibility of water alone being picked up is reduced.

Water Should Separate Readily from Turbine Oil

It might be reasoned that a satisfactory manner of overcoming the trouble would be to use an oil possessing the property of readily emulsifying with water, thus insuring the presence of a uniform mixture in the sump and guarding against unmixed water being supplied to the bearings. No doubt this system would serve for a time, but there is a limit to the amount of water that can safely be allowed in such emulsion, and if the oil were of the type that does not separate at all, it would have to be removed whenever the percentage reached this limit. It is, therefore, desirable to go to the other extreme and to select oil which separates from water as rapidly as possible, the sump then being drained of all intruded water at regular intervals. Great trouble is experienced with the oil which separates slowly from water, since in getting rid of the latter, the oil is unavoidably drawn off also and wasted.

The leading manufacturers of turbine oil have long had in use methods for determining the facility with which their products will separate from water after being churned up in a manner resembling that which obtains in the circulating system of a turbine. These methods vary from simply shaking up by hand with water in a bottle and observing

*From *Engineering* (London), Sept. 21, 1923.

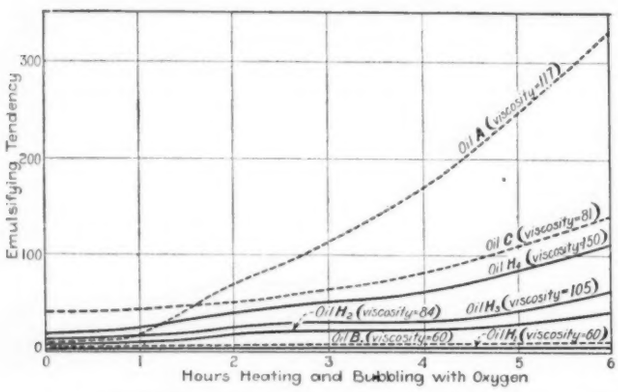
the rate at which oil and water separate, to carefully standardized tests in which a paddle of definite dimensions revolves at a given speed in measured quantities of oil and water, and the resulting emulsion is measured after a fixed period of settling, or the rate of separation is determined by the aid of a gage and stop watch.

Investigation reveals that certain refining processes are particularly valuable in reducing the tendency of oils to emulsify, but another fact of great importance is now appreciated and explained; it is that certain crudes, owing to their chemical composition, yield oils possessing greater resistance to the deteriorating action of air than others.

Oil Oxidizes at Normal Temperatures

Until recent years it was believed that air had no action on refined petroleum products, except at high temperatures, or at least that any action that did take place was so slight as to be negligible in practice. It is now recognized that oxidation proceeds, even at normal temperatures, and considerable attention has been devoted to the characteristics of the products formed.

The earliest textbooks on petroleum taught that the lamp oils and lubricating oils consisted of substances belonging to the "paraffin" series of hydrocarbons, which are characterized by their inertness, but it has since been shown that true members of this series having molecular weight over 198 (tetradecane) are not liquids, but solids, although



CURVES SHOWING RATE OF DETERIORATION OF VARIOUS OILS AS MEASURED BY THE TIME REQUIRED TO SEPARATE FROM WATER

Emulsifying tendency determined by agitating a sample of the oil with water under set conditions. It is expressed as the time in minutes required for the oil and water to separate out. The viscosity of each oil is given by the Redwood Viscometer at 140 deg. F.

in boiling point they may correspond to liquid lubricants which are now known to consist of less highly-saturated hydrocarbons, including olefines and naphthenes. These are capable of reaction with oxygen, yielding at first substances that are soluble in the oil, and later insoluble substances which appear in the form of a brown or yellow solid, a product well known to users of oil-cooled transformers, and which, incidentally, represents the first stage in the formation of solid deposits in cylinders, crank chambers, etc., of internal-combustion engines.

Oxidation Products Prevent Water Readily Separating from Oils

These oxidation products play an important part in the formation of oil-water emulsions and their separation. Emulsions depend for their permanency upon the maintenance of a film at the surface separating the oil and water globule. The molecular forces brought into play at the surface between the two liquids, hinder the rupture of the surface, and it has been shown that certain colloidal substances, when present, concentrate at the surface and help to maintain it intact.

The oxidation products of oil are substances of this emulsion-forming character, and when they are combined with the alkalies which sometimes occur in water, the property becomes still more marked. The annexed diagram shows how the formation of oxidation products renders the emulsion more lasting. For instance, in the case of "A" the time of break-up for a litter of emulsion was 8 minutes. The same oil after 1 hour's oxidation, yielded an emulsion which took 17 minutes to break, and after 6 hours' oxidation the emulsion (still produced by the same amount of agitation) required 5 hours and 33 minutes to break.

The resistance of an oil to the action of air depends upon its chemical constitution. The removal of impurities is generally sufficient to produce a temporarily non-emulsifying oil, but resistance to oxidation depends on the constitution of the oil and, consequently, products refined from different crudes with equal care may be equally satisfactory at first, but whereas one will remain satisfactory over a long period of use, the other will quickly develop a tendency to emulsify. The curves bring out this distinction very clearly. They indicate the time required for a liter of oil to separate from the emulsion formed by stirring with half its volume of distilled water under standard conditions.

Other things beng equal, the thinnest oil will take the least time to separate, since it allows the water to fall more freely, and it is interesting to notice that with the four high-class oils, H.1, H.2, H.3 and H.4, ranging in viscosity from 60 to 150 at 140 deg. F., the rate of separation remains very roughly in the same ratio throughout. The starting point indicates the time of separation for the fresh oil, and the rest of the curve indicates the increasing time required when the oil has undergone oxidation for varying periods.

Light Oils Show Relatively Less Deterioration Due to Oxidation

In the case of "A," the rate of separation is at first equal to that of H.2, and slightly quicker than that of H.3, which approximates to it in viscosity, but after oxidizing for an hour, it becomes slower than that of H.3, and thereafter becomes still slower, the quality at the end of 6 hours' oxidation being much inferior to that of any other oil under consideration.

Curve "B" represents a light oil having the same viscosity as H.1; when fresh, its rate of separation is rapid, the time required being equal to that of H.1. Under the oxidation treatment, the time increases to double that of H.1; in other words, "B" shows a greater falling off in quality.

Curve "C" represents an oil of viscosity equal to that of H.2. There is obviously something amiss with this make of oil, since in the fresh condition the time of separation is eightfold that of the highclass grade H.2. It does not, however, show unduly rapid increase, but resembles rather the curve of a fairly good oil which has already undergone partial deterioration.

While deterioration due to atmospheric action on the warm oils is the principal cause of emulsification, other circumstances contribute their ill effects; for instance excessive access of water or the provision of a sump of inadequate dimensions for settling may result in the circulating pump picking up too much water in spite of the oil being of excellent quality. Again, the entrance of impure water, such as cooling water containing alkalies, may result in secondary actions which render it difficul for the oil to disengage itself.

Another not infrequent source of trouble lies in the fine dust that sometimes accumulates in the oil; this dust may be of atmospheric origin, or it may arise from the corrosion of some part of the machine, and it is not by any means uncommon to find floating particles of finely divided ferric oxide in the sump of a turbine. Such oxide undoubtedly comes from the combined influence of air and water on metallic dust formed by attrition in the circulating pump or, it may be, by actual rusting of iron surfaces with which the oil and water come into contact.

Chemical analysis of the emulsion proves helpful in identifying such sources of trouble and should in any case form part of the investigation.

"Do not put ashes in wooden boxes and baskets or against wooden partitions or building.—If you do the fire department is going to call on you."

Standardization of Engine Stops†

By Walter Greenwood*

In codifying the general safety principles to govern the make and installation of automatic engine stops, consideration should be given to the wide variation in style, construction and purpose of machines they are to be applied to. It seems as though any of the principal makers of engine stops can furnish a design suitable for any requirement if it is rightly installed and maintained, and too, it seems as though it would be hard for anyone who has had an all-around experience with all makes of stops produced by different manufacturers, to decide on a preference to the exclusion of all others. Experience has proved that the following hints are worthy of consideration:

With electrically actuated automatic stops preference should be given to the closed-circuit system. The most serious objection raised against it is, that it possibly is more liable to be unintentionally brought into operation and cause inconvenience than is the open-circuit system. So far as currernt failure is concerned, this can be guarded against; so far as failure of wiring is concerned, it seems best to have it revealed by action of the stop, regardless of the inconvenience that may be caused.

An open-circuit system may be defective or out of order for a considerable period of time before its condition is discovered. Inspection and testing may be much neglected; the battery may have become exhausted or the circuit may be broken. However, these objections to both systems can be minimized to a large extent by proper installation of equipment.

Engine stops should be tested frequently to prove they are in good order. Such tests generally are made by using them when it is necessary to stop the engine, or they are made without stopping it and the reset is made while the engine is running. In addition to such tests, occasionally tests should be made by actually overspeeding. By whatever means overspeed is obtained, provision of some kind should be made for positively preventing the adjustment of the control governor, through ignorance or carelessness of an attendant, so that it will permit overspeed in excess of that which should be required for bringing the automatic stop into action, which speed should not exceed the normal required speed by more than 10 per cent.

Improper kind of packing around valve stems; improper balance of balanced valves; improper method of lubrication of parts of valves, are matters that can cause failure. These, along with other defects in installation and make, could be avoided if proper specifications were strictly followed in all cases, or if daily or even weekly attention were given.

All persons who are responsible for making installations of engine stops, and all persons charged with the responsibility of operating them, should be acquainted with the following list of causes for flywheel explosions, possible combinations and improper methods:

Flywheel accidents are caused by overload or overspeed. Overload suddenly released will cause a flywheel to race. Overload may be produced by:

1. Clogging of the machinery in the mill or factory.
2. Unusual imposition of separate loads at the same time.
3. Careless or ignorant handling of friction clutches.
4. If the engine drives electrical machinery, an overload may be produced by a short-circuit, the sudden releasing of which causes the damage.
5. Sudden stopping of the engine due to obstruction or defects.

Overspeed causes the flywheel to explode by centrifugal force. By overspeed is meant the accidental increase in speed over that at which the flywheel will safely revolve, commonly called racing. Racing may be produced by:

1. Governor being improperly designed.
2. Slipping or breaking of governor belt.
3. Breaking of governor pulley.
4. Derangement of governor by internal or external causes, as when stem sticks or a rod breaks.
5. Derangement in valve gear.
6. Sudden reduction of load as when the main-drive belt or clutch breaks or an armature burns out, etc.

Besides these principal causes there are contributing causes such as:

1. Failure of some part of an engine, as when its bed breaks or its shaft fails.
2. An idle pulley or driving pulley may break and hurl its fragments into the governor or valve gear.
3. Defects in design or material of the flywheel.

When a condensing engine overspeeds, even after the steam has been shut off, unless the vacuum is broken racing may continue until the flywheel explodes.

When an engine starts to race, machines that it drives are shut down by the operators. The decrease in load causes a further increase in speed, which causes the flywheel to burst by centrifugal force.

For automatic engine stops the following combinations are possible:

1. Independent governors may be either: (a) Electrically actuated, (b) steam actuated, or (c) mechanically actuated.
2. Combined trip and throttle valve: (a) With magnet for closed-circuit electrical operation; (b) with solenoid for open-circuit electrical operation; (c) for closed-circuit storage battery; (d) for open-circuit dry battery; (e) to be steam actuated; (f) steam actuated and also fitted for open-circuit electric operation; (g) steam actuated and also fitted with storage battery for open-circuit electric operation; (h) for mechanical operation.
3. Butterfly valve: (a) With magnet for closed-circuit electrical operation; (b) with solenoid for open-circuit electrical operation; (c) with magnet for closed-circuit storage battery; (d) with magnet for open-circuit dry battery.

The following methods and combinations for stopping an engine should not be classified with automatic stops for quick closing:

1. A throttle valve attached through gearing to a motor or any mechanical appliance, for closing the throttle.
2. A mechanical device that is auxiliary to and connected to the control governor.

Rules for Operating Engine Stops

The following rules are suggested for guidance in operation of engine stops:

1. All parts of an automatic engine-stop equipment must be closely watched by attendants and kept in good condition all the time.
2. Engines that are supplied with automatic stops must be shut down by using the stops at least once each day, which means once each turn, if the engine is operated intermittently.
3. Engines that are run continuously for a long period of time must always be shut down when a stop is made, by bringing the quick-closing valve into operation.
4. In addition to using the automatic stop when shutting down an engine, the apparatus must be tested once each day or turn to see if it is in good working condition.
5. Periodically, as conditions or convenience will permit, each engine stop must be tested by overspeeding the engine.
6. When an automatic stop operates unexpectedly and apparently the apparatus is in good condition, trouble should first be looked for in the control governor, and a test should be made by overspeeding the engine.
7. When a control governor is found to be out of order, immediate steps must be taken to put it in good working condition.
8. Where a trip is brought into action by a pin, projected by centrifugal force, the pin should be inspected, cleaned and oiled periodically as conditions will permit.
9. All parts of the valve and tripping devices, subject to wear and interference by foreign matter sticking to parts, must be kept clean and lubricated. Cylinder lubricant must be admitted ahead of the automatic-closing valve.
10. In the case of lubricating valves on steam turbines, if there may be any objection to admitting lubricant on buckets it must be admitted directly on the valve parts, in quantity just sufficient to effect good and continuous lubrication.

---

†Abstract of paper presented at convention, Association of Iron and Steel Electrical Engineers, Sept. 24, 1923, Buffalo, N. Y.

*Safety Engineer, Carnegie Steel Company, Youngstown, Ohio.

Stoker Manufacturers' Association

The fall meeting of the Stoker Manufacturers' Association was called to order at Briarcliff Lodge, Briarcliff Manor, N. Y., on the forenoon of Tuesday, Oct. 23.

Joseph G. Worker, the president, in his opening remarks called attention to the need of industrial education. American industry may need 400,000 more persons for positions of responsibility by 1930 than were employed in 1920. To meet this need of 40,000 new leaders annually, the technical schools are turning out some 9,000 per year. We have more inquiries for skilled men in the boiler room than we can fill. Why cannot this Association give some thought to building up the boiler-room operators of the country?

He stressed the idea of unanimity in the decisions of the Association. Nothing of moment is done until it meets with practically unanimous favor, and he pleaded for patient frank discussion of differences until an agreement is reached.

If the Association would establish a sound plan for handling service and field work, whereby the customer would pay for service rendered necessary by no fault of the stoker, it would probably be one of the greatest advancements in the industry.

He suggested improvement in the Association's product to meet the demands for greater efficiency and durability imposed by the conditions of a more strenuous practice and the competition of other methods of firing; also suggested the possibility of improvement in appearance and finish.

The desirability of continuing the work of the Public Policy Committee, dropped with the adoption of the new by-laws, was mentioned. The Association seeks a better knowledge on the part of the public with its problems and its methods of dealing with them. The Publicity Committee can undoubtedly do much to bring this about.

The Engineering Report, N. E. Lewis, chairman, led to, among other things, a long discussion of refractories for boiler furnaces, and contact committees with the American Society for Testing Materials, the Bureau of Standards and the Refractories Association were authorized.

F. H. Daniels reported for the Fan Committee, looking toward fan specifications that will insure stoker manufacturers in their performance promise.

John Van Brunt, reporting for the A.S.M.E. Conference Committee, suggested a method to be proposed to the Power Test Code Committee for the use of a bag instead of the quartering method of collecting samples to be tested for moisture.

On Tuesday afternoon an interesting discussion with regard to service in case of trouble and the supplying of repair parts, was precipitated by the report of the Commercial Committee, S. A. Armstrong, chairman. The consensus of opinion was that the customer should pay for service rendered necessary by his own mismanagement or unintelligent use of the stoker or by the use of repair parts supplied by others.

In the evening motion pictures were shown by the courtesy of Laclede-Christy Co., exhibiting the processes of manufacture of fireclay products and numerous instances of their use. There was also a series showing Golf Professionals in Action, by the courtesy of Chauncey Depew Steele, and other films of a popular character.

On Wednesday forenoon Edwin B. Ricketts, of the New York Edison Co., read a paper on "Some Factors Affecting the Choice of a Combustion System," in which he compared the stoker and pulverization methods of firing and discussed some of the possibilities of low-temperature distillation. The paper brought out a long and interesting discussion.

A. G. Pratt, reporting for the Cost Accounting Committee, introduced F. H. Figsby, of Ernst & Ernst, who explained in detail the system devised by his firm to the order of the Stoker Manufacturers, and after a brief discussion the system was adopted as the recommended practice of the Association.

On Wednesday evening there was a banquet, and Thursday forenoon was devoted to the golf competitions, which had been rendered previously impossible by weather conditions.

World Power Conference Committees Are Active

The American Committee of the World Power Conference to be held in London, June 30 to July 12 of next year, is holding frequent meetings, perfecting its organization, selecting authors and subjects for American contribution to the program and arranging the details.

O. C. Merrill, executive secretary of the Federal Power Commission, Washington, D. C., is general chairman and William M. Steuart, Director of the Bureau of Census, Washington, D. C., is secretary of the American Committee.

The American program of papers is still in its formative stage. Those arranged by the British Committee are:

Papers Arranged to Date

Section A: "The Coal Resources of the World," Sir Richard Redmayne, K.C.B.; "National Review of Water Power in Great Britain and Ireland," Prof. A. H. Gibson, D.Sc.

Section B: "Problems Relating to Run-off, Storage, and the Allocation of Catchment Areas in Great Britain and Ireland," W. J. E. Binnie; "Points Affecting Economy in General Lay-out and Design," C. M. Norrie and W. H. Munro; "The Scope of Development to Meet Progressive Demands," E. C. Bergstrom.

Section D: "Steam Generation," Sir James Kemnal, Kt.; "Steam Turbines," The Hon. Sir Charles Parsons, K.C.B.

Section E: "Internal Combustion Engines," James Richardson.

Section G: "The Transmission and Distribution of Electrical Energy," C. H. Merz; "Large Generators," A. B. Field; "High Voltage D.C. Generation and Distribution of Electrical Energy," J. S. Highfield; "Mechanical and Hydraulic Variable Transmission of Power," Dr. H. S. Hele-Shaw, F.R.S.

Section H: "The Application of Electrical Energy," Sir Alexander Kennedy, F.R.S.

Section K: "Application of Power to Rail Transport," Roger T. Smith and C. B. Collett; "Application of Power to Road Transport," Col. R. E. Crompton, C.B.

Section L: "Illumination," C. W. Sully.

Section M: "The Financial Aspect of Hydro-electric Development," George Balfour, M.P.

Section N: "International Standardization," C. le Maistre, C.B.E.; "The Education of the Apprentice," Prof. A. P. Lawrie, D.Sc., and Prof. F. G. Baily; "The Education and Training of the Engineer of the Future," A. P. M. Fleming, C.B.E.; "The Importance of Greater Public Interest in Mechanical Progress," T. C. Elder; "Co-operative Publicity in the Public Supply of Electricity," J. W. Beauchamp; "The Study of the Human Element in Production," D. R. Wilson; a paper by Dr. C. S. Myers, F.R.S.

Papers Under Consideration

Section A: "National Survey of Fuel Resources"; "Oil Resources."

Section C: "The Winning and Utilization of Peat"; "The Winning and Utilization of Lignites"; "The Design and Operation of Gas Producers"; "The Utilization of Powdered Coal."

Section D: "Steam Generation and Utilization at Higher Temperatures and Pressures"; "Modern Developments in Reciprocating Engines."

Section E: "The Mechanism of Combustion of Gases."

Section G: "Power Factor Improvement"; "High Voltage Cables."

Section H: "Recent Research in the Economic Utilization of Electrical Energy."

Section K: "Application of Power to Water Transport"; "Application of Power to Air Transport."

Section N 6 (a): The British Empire Producers' Organization, with the consent of the Conference Executive Committee, are undertaking to present special papers on British Empire Resources in Relation to Power—"The Mineral Resources of the British Empire as Bearing on Power Machinery"; "Alcohol as a Source of Power"; "Power Areas and Possibilities of Industrial Development."

News in the Field of Power

Attractive Programs for the A.S.M.E., A.S.R.E. and Power Show Are Promised

Three Sessions of the A.S.M.E. Will Be Devoted to Power: Heat Balance and Boiler Room Economy—Water Flow Measurement—Coal Storage

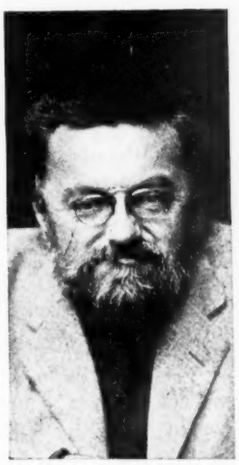
SOME of the subjects to be discussed at the annual meeting of the A.S.M.E. are: "Heat Transfer for Fluids Flowing Inside Pipes," by Wm. H. McAdams and T. H. Frost; "A Steam Loss Prevention Plan in a Textile Finishing Plant," by Henry M. Burke; "A Graphical Study of Journal Lubrication," by H. A. S. Howarth; "Factors in the Spontaneous Combustion of Coal," by O. P. Hood; "Economic Phases of Coal Storage," by F. G. Tryon; "Coal Handling and Coal Storage," by H. E. Birch and H. V. Coes; "Economy Characteristics of Stage Feed Water Heating by Extraction," by E. H. Brown and M. K. Drewry; "High Pressure, Reheating and Regenerating for Steam Power Plants," by C. F. Hirschfeld and F. O. Ellenwood; "Reheating in Central Stations," by W. J. Wohlenberg; "Margins of Improvements in Central Station Steam Plant," by E. L. Robinson; "Boiler Plant Economics," by N. E. Funk and F. C. Ralston; "Economic Status of the Oil Engine," by L. H. Morrison; "Salt Velocity Method of Measuring Water," by C. M. Allen and E. A. Taylor; "The Gibson Method and Apparatus for Measuring the Flow of Water in Closed Conduits as Applied in Testing the Efficiencies of Water Wheels in Hydro-Electric Power Plants," by N. R. Gibson.

In addition to these topics the power test codes committee of the society will hold a public hearing on the Code for Stationary Steam Generating Units and the Code for Locomotives. There will be an open meeting at which the report of the fluid meters committee will be discussed. Progress in the program of society research and steam tables will also be treated at this meeting.

Further the A.S.M.E. Professional Divisions on Aëronautics, Machine Shop Practice, Management, Ordnance, and Forest Products will hold sessions of general interest to the engineering profession.

The American Society of Refrigerating Engineers is to hold its meeting at the Hotel Astor for 3 days, commencing Dec. 3, and its members as well as the members of the American Society of Mechanical Engineers will be admitted to the Power Exposition upon presentation of their membership cards, or the showing of membership badges. The Refrigerating Engineers are preparing an interesting program.

The Power Exposition offers a remarkable opportunity for the operating man to become acquainted with the latest devices in his field. This opportunity will be seized by the National Association of Stationary Engineers, the New York Building Owners and Managers Association, the New York Building Superintendents' Association, the Blue Room Engineering Society and the Ocean Associations of Marine Engineers, who will attend the exposition in groups.



CHARLES P. STEINMETZ

Steinmetz Died Suddenly on October 26

Charles Proteus Steinmetz, chief consulting engineer of the General Electric Co., died suddenly on the morning of Oct. 26, of acute myocarditis.

Born April 9, 1865, at Breslau, Germany, and educated at the gymnasium and university there, he became involved in the social democratic agitations going on and was obliged to flee to Switzerland to escape the displeasure of the German government. He studied mechanical engineering at the Polytechnicum of Zurich for a year and then emigrated to America in 1889. Practically penniless for a time, he found his first employment with the Eickemeyer-Field Manufacturing Co. as draftsman and quickly became electrical designer, finally being put in charge of the research laboratory. When the General Electric Co. absorbed the Eickemeyer-Field Manufacturing Co. in 1894 he went with the organization to Schenectady, where his great genius in electrical engineering and research work and his clear, forceful reasoning have made him the outstanding figure in his field.

Dr. Steinmetz's wonderful laboratory, greenhouses and home, although he had no family, never having married, constituted one of the show places of Schenectady, where his fondness for children and young college students made a place in the community that cannot be filled. He also had a camp on the Mohawk, at which he spent his summers, combining work in his laboratory there and pleasure in the beauties of nature.

At the conventions of electrical associations he had become the dominant personality with his distinctive voice, the quaint accent, the clearness and force of his phrases, and the close-knit reasoning which advanced to unanswerable conclusion.

Pulverized Coal Transported 5,400 Ft. Through 5-in. Pipe

It has often been asked, how far can pulverized coal be readily transported with the equipment now available.

This is a question that confronts many engineers when laying plans for a plant in proximity to a mine or where the coal handling facilities are more conveniently located some distance from the plant site.

With a view to determining what is possible in this respect a series of experiments have been conducted by the Fuller-Lehigh Co. of Fullerton, Pa., which have resulted in the satisfactory transporting of pulverized coal through a 5-in. pipe for a distance of 5,400 ft.

The tests were made on the standard Fuller-Kinyon system consisting essentially of a revolving screw pump which starts the mass in motion and at the discharge end of the pump the mass is aërated by a number of small volume streams of compressed air at moderate pressure. This changes the nature of the material from a compact mass to a semi-fluid in which state it is carried to the point of discharge.

The ability to transport pulverized coal in this manner over long distances will greatly increase the flexibility and adaptability of this fuel where it is necessary to locate the coal preparation plant some distance from the furnaces.

Western Electric Co. Building New Plant at Kearny, N. J.

Construction of the Western Electric Co.'s new cable and telephone switchboard plant on the 60-acre tract in Kearny, N. J., has begun. Work on the cable buildings and the 1,600-ft. bulkhead on the Passaic River is well under way.

The cable plant will have an initial capacity of about 210,000,000 conductor feet of loop cable per week, and it is expected that this part of the plant will be in operation by the fall of next year. One of the cable buildings will be given over to armoring telephone cables for use under rivers and in harbors.

Another section of the plant consisting of a series of six-story buildings with a total floor space of approximately 693,000 sq.ft., will include facilities for the manufacture of telephone switchboards. These buildings will be completed during the year 1925.

To serve the manufacturing building, a power plant with an initial capacity of 8,000 kw. will be erected. The plant will be laid out for a ultimate capacity of 20,000 kw. Further details on the equipment will appear in an early issue.

W. R. Kattelle, the Western Electric Company's architect, is in immediate charge of the plans and execution of the work on the new plant. McKenzie, Voorhees & Gmelin are the consulting architects, with the J. G. White Engineering Corporation and Charles W. Staniford as consulting engineers.

Coal Advisory Committee To Be Formed

The advisory committee, which is being set up to co-operate with the coal division of the Department of Commerce, will be composed of fifteen members. Three members will represent each of the following branches of the industry: Bituminous operators, anthracite operators, wholesalers, retailers and transportation. The personnel of the committee has not been determined as yet.

Hoover Honorary President of Engineering Congress

Herbert Hoover has accepted the honorary presidency of the Engineering Congress, which is scheduled to be held in connection with the Sesqui-Centennial Exhibition in Philadelphia at Fairmont Park in 1926. The Sesqui-Centennial Exhibition is being held in commemoration of the Centennial Exhibition held in that historic city fifty years before. Plans for the Engineering Congress have been under way for some time and it promises to be of immense interest to the engineering fraternity.

Coal Commission Report Says That Speculators and Jobbers Take Huge Profits

It Shows the Futility of State Legislation on Coal—Profits Taken by Wholesalers and Others—Community Licensing of Dealers Approved

IN THE Coal Commission's Report on "Wholesale and Retail Coal Trade," relating to both anthracite and bituminous coal, the statistics of margins, expenses and profits are given in considerable detail, in the hope, it is stated, of making the information more useful locally. It quotes car number lots and names of the towns where wholesalers operated in selling and reselling car numbers and weights without physically handling the coal at all. In addition to showing that the wholesalers' earnings have risen 200 per cent from pre-war prices, that single dealer's margins amounted up to as high as $4.20 per ton, were resold through as many as four wholesale dealers before reaching the retailers, the Commission found state regulation over mine, wholesale prices and distribution to be very limited. It reported that where state regulating legislation was introduced, the operators shipped the coal outside the state, obliging the citizens to buy coal from another state at increased prices. It concluded this report by stating that communities by licensing the retail dealers could control in a measure the quality and price. Retail dealers were treated in a gentler manner than were the wholesalers.

Other reports of the Commission that have been received since the Commission went out of existence on Sept. 22, are: "Purchase of Coal on Contract"; Engineering and Management Studies"; "Labor Turnover in the Bituminous Coal Industry"; and "Wage Rates in the Bituminous Industry."

World Production of Coal for Six Months Estimated

The Geological Survey has made a summary of the world production of coal for the first six months of 1923, which shows that 666,000,000 tons was mined during that time and indicates an increase of about 79,400,000 tons, or 13.3 per cent over the corresponding period of last year. All the countries listed, with the exception of Austria, Czechoslovakia and Germany, have increased their production. The most notable increases were in the United States, the United Kingdom and Poland.

The table, which follows, gives in percentages the estimate for each country and includes estimates for those countries, representing about 5 per cent of the whole for which no figures were available. The estimate for Germany is included in the total and is based on complete data for January and February and incomplete data thereafter.

Country	Per Cent of Total
North America:	
Canada	1.19
United States	44.18
Other countries	(a)
South America	(a)
Europe:	
Austria: Coal	0.01
Lignite	0.19
Belgium	1.67
Czechoslovakia: Coal	0.88
Lignite	1.31
France: Coal	2.65
Lignite	0.06
Germany: Coal b	(c)
Lignite	(c)
Hungary	0.45
Netherlands	0.4
Poland	3.25
Russia	0.84
United Kingdom	21.50
Other countries	(a)
Asia:	
British India	1.51
Japan	2.06
Other countries	(a)
Africa:	
Rhodesia	0.04
Union of South Africa	0.78
Other countries	(a)
Oceania	(a)
Total	100.00

(a) Estimate included in total.
(b) Includes 2,688,654 tons from Saar.
(c) Estimate, based upon incomplete reports, included in total.

Operating Records Discussed at Huntington

The mechanical and electrical engineers in the West Virginia-Kentucky coal regions have a small but active professional society, whose object is "the advancement of knowledge of its members by exchange of ideas, reports and discussion of experiences." This organization, known as the "West Virginia-Kentucky Association of Mechanical and Electrical Engineers," held its third annual convention in Huntington, W. Va., Oct. 18 and 19.

While the majority of the papers dealt with mining problems, the subject "Mechanical and Electrical Equipment Records," as presented by J. H. Edwards, was of general interest to engineers operating equipment of any kind.

As electrical engineer for the Elkhorn Piney Coal Mining Co. Mr. Edwards explained the system of equipment records used by his company. This system, he said made it easy for a new superintendent, engineer or electrician to become familiar with the equipment under his supervision. It also eliminated costly delays and mistakes in ordering repair parts and making repairs. The adoption of such a system, he said, would make it possible to find at once the essential data on any machine even if the manufacturer's name-plate and serial number were lost.

In the scheme adopted, each piece of equipment is provided with a plant name-plate stamped with the company initials, a class letter and an individual number. This plate is of small size (1x1½ in.) so as to be easily attached to any piece of equipment, large or small. It is held in place by drive screws, thus doing away with tapping holes for machine screws and making removal difficult.

A data sheet with the same number and class letter as the name-plate is

provided for each machine. Letter size sheets (8½x11 in.) were selected instead of index cards, in order to have plenty of space for recording the original data and making additions from time to time. Each sheet is punched on the side for a ring binder. Where necessary additional carbon copies are easily made. In Mr. Edwards' opinion the ring binder sheets are more likely to be kept in filing order than index cards.

It was considered impracticable to make a single printed data form suited to all types of equipment, so eight forms were prepared with class letters as follows: Class B, Stationary boilers, feed heaters, steam separators, feed water meters; Class C, Coal cutting machines; Class E, Motors, transformers, converters, motor-generator sets, switchboard panels, large circuit breakers, automatic motor starters, etc.; Class F, Mine fans and blowers; Class L, Mine locomotives; Class M, Miscellaneous; Class P, Pumps, compressors, turbines and engines (including direct-connected complete units); Class S, Steam locomotives, steam-driven concrete mixers, cranes, shovels, etc.

The form used for each class of equipment contains blanks for the same items commonly found. In addition there is space to copy all name-plate data, date purchased, price, cost, manufacturer's guarantee and any other information likely to have reference value. The details of important changes and repairs are entered on the back of the sheet. The aim of the system is to give the maximum of service with a minimum of red tape.

Milwaukee Engineers Hold Annual Convention

The Engineers' Society of Milwaukee held its annual meeting at the Milwaukee Atheltic Club, Oct. 17. It was a dinner meeting with an attendance approximating one hundred. In a preliminary business session reports from the various committees were heard and officers for the ensuing year were elected as follows: Fred H. Dorner, president; F. C. Trubshaw, vice-president; Walter R. Mueller, treasurer; Robert Cramer, secretary; Ralph Cahill, Fraser Jeffrey and H. W. Rohde, directors.

The topic of the evening was "The International Iron and Steel Situation in Its Bearing Upon the Ruhr," and the speaker, C. K. Leith, professor of geology at the University of Wisconsin. In his opening remarks the speaker referred to the present intensive use of the world's mineral resources and to the grouping of the iron and steel industries into three great units—one in the United States, one in England and the other in what was called the Ruhr district. These three units, he said, furnish 93 per cent of the world's production in iron and steel, and of the three the American unit is the largest, producing over one-half of the total. The locations of the iron ore and of the steel mills in the three units were reviewed briefly and reference made to the availability of iron ore in other parts of the world.

On the Ruhr district the speaker centered his address, reviewing the complex relationship between the different component parts of the unit and showing why it would be impossible to duplicate such a unit in Germany. The proximity of coal and cheap transportation were the factors determining the location of these units. At the present they were of such importance as to transcend national boundaries and in the future they would continue to focus increasing production, creating international problems of various sorts. The control of the present Ruhr development was a matter of vital importance. Whether this control will remain with France or go back to Germany or a buffer state be created, unity control was one of the essentials for successful world competition. It carried with it political supremacy in Europe, and if France can make the present arrangements function, the reparation issues now under discussion will be trivial in comparison.

New Publications

Foreign Commerce Handbook 1923-24. By Foreign Commerce Department of the Chamber of Commerce of the United States, Mills Building, Washington, D. C. Paper. 37 pages.

This handbook contains information that should be of considerable usefulness to manufacturers who are thinking of the export field. It contains bibliographies of publications, information as to where to get data on such subjects as freight rates, harbor charges, foreign exchange, packing, moneys, samples, travelers abroad, trade opportunities; in fact, the subject is covered from one end to the other and arranged in a convenient form, alphabetically, and with an index.

Motor & Generator Operators' Handbook—Detailed instructions for the proper installation, operation and care of electric motors and generators are given in a booklet which has been prepared and just published by the Motor and Generator Section of the Electric Power Club, Cleveland, Ohio. These instructions are grouped under the five following headings: General installation, method of drive, operation, care and maintenance.

It is recognized that the life and successful operation of electric motors and generators depend upon their proper installation and maintenance as well as upon their proper design and manufacture. While motors and generators require less care than almost any other type of power apparatus, neglect of certain fundamental requirements may lead to serious trouble if not to the loss of the equipment. A wide distribution of information of this character is, therefore, important and these brief instructions have been prepared for the assistance of those responsible for the installation, operation and maintenance of electric motors and generators.

Standard definitions referring to motors and generators are also given in this booklet, copies of which may be obtained from member companies of the Motor and Generator Section of the Electric Power Club.

United States Petroleum Oil Tables—Prepared by the United States Bureau of Standards. Adopted by the American Petroleum Institute, the United States Bureau of Mines and the United States Bureau of Standards. This table shows the volume occupied at 60 deg. F. by a quantity of oil of any A.P.I. gravity at 60 deg. F. occupying unit volume at the indicated temperatures. The values given in the body of the table are in the form of multipliers, that is, the volume of oil at the indicated temperature and degrees A.P.I. multiplied by the corresponding factor in the table equals the volume at 60 deg. F. This table can also be used to calculate the percentage change of volume to reduce to 60 deg. F. The table is based on results of an investigation conducted by the Bureau of Standards on the "Density and Thermal Expansion of American Petroleum Oils," and published as Technologic Paper No. 77.

Society Affairs

The **Columbus Section of the A.I.E.E.** will hold a meeting on Feb. 15 at which "Superpower" will be discussed.

The **Greater New York, Combined Associations of the N.A.S.E.** will hold their annual dinner and entertainment Saturday evening, Dec. 1, at the Hotel Commodore.

The **Metropolitan Section of the A.S.M.E.** will hear a paper, "The Use of Fuels in Industrial Heating Operations," by Joseph A. Doyle, of the W. S. Rockwell Co., at Newark, N. J., on Oct. 31.

Obituary

William L. Cosgrove, aged 64, formerly president of the Atlanta Gas Light Co., died suddenly on Oct. 8, in the Kent Hospital, Kent, England. Mr. Cosgrove was an engineer by profession, having spent his early life as a civil and construction engineer in Chicago. Later he became connected with the Northwestern Railroad, where he remained for a number of years, finally going to Atlanta, where he was with the Georgia Railway & Power Co. and also became prominently identified in local engineering circles. Two years ago with his wife he went to Europe for an extensive tour. He remained in excellent health until around the first of September, when he suffered a slight apoplectic stroke at Lac de Como, and later in London was striken with paralysis from which he never recovered.

Personal Mention

James F. Muir, formerly mechanical engineer for Toltz, King & Day, Inc., St. Paul, Minn., has become associated with Stone & Webster, Inc., Boston, Mass., as engineer in the mechanical division.

Emile Prat, Directeur General des Establishments E. Prat — Daniel of Paris, France, is at the Plaza Hotel, New York City, and would be glad to meet those who are interested in the subject of the preheating of air and water for boilers by the use of flue gases.

Frederick H. Newell and **Otto M. Rau** have been appointed to the staff of the Giant Power Survey of Pennsylvania by Morris L. Cooke, the director. Dr. Newell will be stationed in Harrisburg and have charge of the study of coal and water resources. Mr. Rau will have his office in Philadelphia and direct the study of power requirements, stations and transmission lines.

Business Notes

The Detroit Stoker Co. announces the appointment of E. L. Beckwith as district manager in charge of the company's Chicago office, 230 South Clark St., Chicago, Ill.

The Continental Valve Equipment Co., 80 East Jackson Boulevard, Chicago, Ill., announces the appointment of Robert L. Sheraton, formerly with the Edward Valve Co., as vice-president in charge of sales.

The Triumph Electric Co. & The Triumph Ice Machine Co., Cincinnati, Ohio, announce that E. C. Morse has joined their organization as vice-president in charge of sales and as member of the board of directors.

The Westinghouse Electric & Mfg. Co., has established at its South Philadelphia Works, a general engineering division which will be devoted to the study of central-station and industrial-plant problems, which involve the application of steam-power apparatus such as steam turbines, condensers and reduction gears. This department will also co-operate with the sales organization in providing engineering service to purchasers of this equipment.

Himelblau, Agazim & Co. have moved recently into larger quarters at 30 North Dearborn Street, Chicago, Ill. The firm is now representing the following accounts in the Chicago territory: Charles Engelhard, Inc., New York City, manufacturer of an electric CO_2 recorder and pyrometric equipment; Cooling Tower Company, Inc., of New York City, making air washers and water-cooling equipment; Smith Gas Engineering Co., of Dayton, Ohio, builders of clean gas producers, calorimeters, etc.

The Schubert-Christy Construction & Machinery Co., with offices in the Railway Exchange Bldg., St. Louis, Mo., is the name of a new firm recently organized by Frank H. Schubert, district manager of the Wheeler Condenser & Engineering Co. and William G. Christy, formerly with the St. Louis Boat & Engineering Co. In addition to representing leading manufacturers of power-plant equipment, they will render general construction engineering service in the design and construction of water-cooling equipment for refrigerating and power plants.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institution Bldg., Washington, D. C. Seventy-fifth anniversary meeting at University of Cincinnati, Cincinnati, Ohio, Dec. 27-Jan. 2.

American Engineering Council of the F.A.E.S. L. W. Wallace, 24 Jackson Place, Washington, D. C. Meeting at Washington, D. C., Jan. 10-11.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Midwinter convention at Philadelphia, Feb. 4-8.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 3-6.

American Society of Refrigerating Engineers, William H. Ross, 35 Warren St., New York City. Nineteenth Annual Convention at New York City, Dec. 3-5.

American Society of Safety Engineers. Genevieve S. Wood, 29 West 39th St., New York City. Annual meeting at New York City, Jan. 18.

Association of Railway Electrical Engineers. Jos. A. Andreucetti, Room 413, Chicago & Northwestern R.R. Station, Chicago, Ill. Thirteenth Annual Convention at Hotel La Salle, Chicago, Ill., Nov. 6-9.

Electric Power Club, S. N. Clarkson, 900 B. F. Keith Bldg., Cleveland. Fall meeting at French Lick Springs Hotel, French Lick, Ind. Nov. 19-22.

National Association of Practical Refrigerating Engineers; Ed. H. Fox, 5707 W. Lake St., Chicago. Fourteenth Annual Convention at Memphis, Dec. 12-16.

National Electric Light Association —Southeastern Division. Charles A. Collier, Georgia Railway & Power Co., Atlanta, Ga. Meeting at Hillsboro Hotel, Tampa, Fla., Nov. 19-22.

National Exposition of Power and Mechanical Engineering; Charles F. Roth, Room 1102, Grand Central Palace, New York City. Power Show, Dec. 3-8.

National Marine Engineers' Beneficial Association. Geo. A. Grubb, 313 Machinists' Bldg., Washington, D. C. Annual Convention at Franklin Square Hotel, Washington, D. C. Jan. 21-26.

New England Association of Commercial Engineers; James F. Morgan, 53 Devonshire St., Boston, Mass. Power Show at Mechanics Bldg., Boston, Mass., Oct. 29-Nov. 3.

Society of Automotive Engineers, Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at General Motors Bldg., Detroit, Mich., Jan. 22-25.

Society of Naval Architects and Marine Engineers. Daniel H. Cox, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 8-9.

Trade Catalogs

Burner, Gas—Lee B. Mettler Co., 634 San Fernando Bldg., Los Angeles, Calif. Catalog describing the surface combustion gas burner, multi-mix burner, stack damper indicator, combination burner and confined combustion chamber, combination oil and gas combustion units, fuel-oil burners.

Belt Tension Regulator — Patent Laughton Drive Co., Ltd., 84 Bridge St., Sheffield, England. American Representative Will E. Sheel, 1547 Third St., N.W., Washington, D. C. Catalog showing by means of pictures this device to overcome the troubles of belt transmission drives.

Diesel Engine—Morse Dry Dock & Repair Co., Fifty-sixth St., Brooklyn, N. Y. Special Diesel Number of "Morse Dial" contains an interesting description of an installation of a Diesel-engine plant in a meat-packing establishment in Brooklyn and other material in regard to marine Diesel installations.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Oct. 15, 1923	Oct. 22, 1923
Pool 1,	New York	$3.00@3.25	$2.85@3.25
Smokeless,	Columbus	2.85@3.25	2.85@3.25
Clearfield,	Boston	1.50@2.50	1.50@2.40
Somerset,	Boston	2.00@2.75	1.75@2.75
Kanawha,	Columbus	1.75@2.00	1.75@2.00
Hocking,	Columbus	1.75@2.00	1.75@2.00
Pittsburgh No. 8	Cleveland	1.85@1.95	1.80@1.90
Franklin, Ill.	Chicago	2.25@3.00	2.25@3.00
Central, Ill.	Chicago	2.00@2.25	2.00@2.25
Ind. 4th Vein,	Chicago	2.50@2.75	2.50@2.75
West Ky.,	Louisville	1.50@2.00	1.50@1.85
S. E. Ky.,	Louisville	1.75@2.25	1.50@2.00
Big Seam,	Birmingham	1.75@2.15	1.75@2.15

FUEL OIL

New York—Oct. 25, light oil, tank car lots, 28@34 deg. Baumé, 3¾c. per gal., 36@40 deg. 4c. per gal., f.o.b. Bayonne, N. J.

Chicago — Sept. 28, 24@26 deg. Baumé, $1.82@2.07 per bbl.; 32@36 deg., $2.02@2.07 per bbl., tank cars.

St. Louis—Oct. 16, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.60 per bbl.; 26@28 deg., $1.65; 28@30 deg., $1.75; 32@36 deg., gas oil, $1.85; 36@40 deg., distillate, 4¾@5c. per gal.

Pittsburgh—Oct. 18, f.o.b. local refinery, 30@34 deg., fuel oil, 5½c. per gal.; 36@40 deg., fuel oil, 5¾c.; 34 deg., neutral 8c.

Dallas—Oct. 11, f.o.b. local refinery, 26@30 deg., $1.35 per bbl.

Cincinnati—Oct. 16, tank-car lots f.o.b. local refinery, 26@30 deg. Baumé, 5c. per gal.; 30@32 deg., 5¼c.; 38@42 deg., distillate, 6½c.

Philadelphia—Oct. 24, 26@28 deg., $1.68@1.722 per bbl.; 16@20 deg., $1.64@1.68; 14@16 deg., $1.57@1.612.

New Plant Construction

PROPOSED WORK

Ala., Florence—The city is in the market for an electric pump, 1,000 g.p.m. Noted Oct. 23.

Ala., Gadsden—The Alabama Power Co., B. M. Bldg., Birmingham, has applied to the Alabama Public Service Co. for permission to construct a hydro-electric plant to develop 100,000 hp. at Lock 2-3 on the Coosa River about 20 mi. from here.

Ala., Montgomery — The Office of the United States Engineer will receive bids until Nov. 24 (change of date) for furnishing one steam boiler with fixtures, stack, etc., for United States [illegible] at Columbus, Ga. Noted Sept. 11.

Calif., El Segundo — The El Segundo School Dist., F. M. Bell, Clk. will receive bids until Nov. 5 for furnishing a centrifugal pump capacity 86,000 g.p.d.

Calif., Los Angeles—The Los Angeles county supervisors have appropriated $50,000 for exploration of site for proposed dam at forks of the San Gabriel River. Tentative plans have been made for a dam 450 ft. high, 1,400 ft. long at top, to impound flood water of San Gabriel River for the entire San Gabriel Valley. Total estimated cost $20,000,000. If the location is found feasible for a dam the county will be asked to vote bonds for its construction as a flood control measure.

Calif., Los Angeles — K. Macdonald, Archt., 1305 Brack Shops Bldg., is receiving bids for the construction of an 11 story, 100 x 150 ft. store and loft building on Broadway between 9th and 10th Sts., for A. C. Blumenthal and associates, Loew State Bldg. Estimated cost $700,000. Equipment detail not reported. Noted Oct. 2.

Calif., Los Angeles—A syndicate is having plans prepared for the construction of a 13 story, 100 x 120 ft. office building on 5th and Hill Sts. Estimated cost $1,500,000. Curlett & Beelman, 408 Union Bank Bldg., Los Angeles, Archts. Equipment detail not reported.

Calif., Morgan Hill—The town is having plans prepared for the construction of a sewer system and a sewage disposal plant, consisting of a treatment plant modified; Imhoff tanks with separate sludge beds; sprinkling filter, etc.; two 5 hp. motors and two 4 in. pumps. C. C. Kennedy, Call Bldg., San Francisco, Engr.

Calif., Oakland—The Central Natl. Bank and the Central Savings Bank, 14th St. and Broadway, are having plans prepared for the construction of a 20 story office, store and bank building. Estimated cost $2,000,000. W. Knowles, Central Bank Bldg., Oakland, Archt. Equipment detail not reported.

Calif., San Diego—The Atchison, Topeka & Santa Fe Ry. Co., 6th and Main St., Los Angeles, is having plans prepared for the construction of a creosoting plant, including power house and tanks, here. Cost will exceed $200,000. D. Murray, c/o owner, Engr.

Calif., Santa Monica—A. C. Blumenthal, et al., Loew State Bldg., Los Angeles, is having plans prepared for the construction of a 14 story hotel on Ocean Blvd. and Santa Monica St., here. Cost will exceed $850,000. K. Macdonald, Brack-Shops Bldg., Los Angeles, Archt. Equipment detail not reported.

Ga., Atlanta—H. R. and C. R. Cannon are having plans prepared for the construction of a 12 story, 115 x 143 ft. hotel, including heating plant and installation of three elevators, on Peachtree and Cain Sts. Estimated cost $1,250,000. G. L. Preacher Co., Healy Bldg., Atlanta, Archts.

Ga., Fort Benning—The Constructing Quartermaster will receive bids until Nov. 16 for the construction of six double sets of officers' quarters, a 3 story, 48 x 288 ft. hospital, heating plant, etc. Separate bids will be received.

Ill., Chicago—The A. F. & A. M. of the State of Illinois, E. Beach, Grand Master, c/o Rapp & Rapp, Archts., 190 North State St., is having plans prepared for the construction of a 21 story masonic temple, office and theater building, including steam heating system, on Randolph St. near Dearborn St. Estimated cost $5,000,000.

Ill., Chicago — The Iroquois Club, 26 North Dearborn St., is having plans prepared for the construction of a 21 story club building, including steam heating system, on Michigan Ave. and Lake St. Estimated cost $3,500,000. J. Hunt, 30 East Ontario St., Archt.

Ind., Indianapolis—The Monument Circle Realty Co., Fletcher Bldg., A. Zukor, 485 5th Ave., New York, Pres., will soon award the contract for the construction of a theater and office building on Monument Circle and Main St. Estimated cost $1,500,000. A. W. Johnson, 247 Park Ave., New York, Archt. Equipment detail not reported.

Ind., Mishawaka—The La Salle Paper Co., 403 East Madison St., South Bend. C. E. Nicely, Pres., will soon receive bids for the construction of a 1 story, 50 x 400 ft. mill and power plant, here. Estimated cost $300,000. Freyermuth & Maurer, Farmers' Trust Bldg., South Bend, Archts.

Kan., Arkansas City—The city, M. N. Sinnott, Clk., is having plans prepared and will soon receive bids for waterworks improvements, including extensions to mains, equipment for one remote control house pump, c.i. pipe, gate valves, boxes, fire hydrants, two hundred meters, two wells, etc. Estimated cost $50,000. D. Lawhe, Arkansas City, Engr. Noted Oct. 16.

Ky., Bowling Green — The Porter Provision Co. plans to build a 1 story packing and cold storage plant. Estimated cost $40,000.

Ky., Sutton—The Sutton Coal Co. plans to develop a large tract of coal land in Pike County and will purchase coal handling machinery, etc. Cost will exceed $25,000.

La., Gibsland—The city will hold an election Nov. 8 to vote $50,000 bonds for the construction of an electric light plant, waterworks and distribution mains. E. T. Archer, New England Bldg., Kansas City, Mo., Engr. Noted Oct. 16.

La., Ponchatoula—W. R. Haight, Mayor and Bd. of Aldermen, Town Hall, will receive bids until Nov. 20 for waterworks improvements, including two 750 g.p.m. fire pumps, either motor driven, centrifugal or oil engine driven; 6 in. water well; 50,000 gal. steel tank and tower; 125,000 gal. concrete reservoir; furnishing and laying c.i. or steel pipe; hydrants, valves, fittings, etc.; pump house; also sewerage system improvements; disposal works, consisting of pumping plant; Imhoff tank with dosing chamber; sprinkling filter and sludge beds; c.i. and vitrified sewer pipe. Swanson-McGraw, Inc., United Fruit Bldg., New Orleans, Consult. Engrs.

Mich., Detroit — J. Barlum, 206 East Grand River Ave., is having plans prepared for the construction of an 8 story, 50 x 200 ft. hotel, including steam heating equipment, on Woodward Ave. Bonnah & Chaffee, 528 Farwell Bldg., Detroit, Archts.

Mich., Detroit — The Edmonton Bldg. Corp., c/o Beckett & Akitt, Archts., 73 Monroe Ave., is having plans prepared for the construction of a 5 story, 100 x 200 ft. community hall, store, recreation building, etc., on Grand River and Linfield Aves. The architect will purchase elevators, mechanical refrigerators, steam heating boiler and equipment.

Mich., Detroit—The Henry Ford Hospital, West Grand Blvd., will soon award the contract for the construction of a 6 story, 189 x 289 ft. nurses' home, including steam heating equipment, on Haimlton Ave. and Grand Blvd. A. Kahn, 1000 Marquette Bldg., Detroit, Archt.

Mich., Detroit — The Jefferson & Belle Isle Realty Co., c/o M. Friedberg, Secy., 1254 Griswold St., is having plans prepared for the construction of a 1, 2 and 3 story, 386 x 820 ft. amusement building, including steam heating plant, on East Jefferson St. Estimated cost $3,000,000. C. H. Crane, 542 Griswold St., Detroit, Archt.

Mich., Detroit—P. A. Miller, et al., 600 Majestic Bldg., are having plans prepared for the construction of an 11 story, 150 x 175 ft. club house, including steam heating and elevator equipment, on Case Ave. and Putnam St. Estimated cost $3,000,000. Baxter, O'Dell & Halpin, 1024 Hammond Bldg., Detroit, Archts.

Mich., Detroit — Varney & Varney, Archts., 1422 Washington Blvd., are receiving bids and will open same about Nov. 1 for the construction of an 8 story, 90 x 150 ft. hotel, including steam heating system, on Alexandrine Ave. Estimated cost $400,000. Owner's name withheld. Noted Sept. 18.

Mich., Eloise — The Eloise Hospital is having preliminary plans prepared for the construction of a 4 story addition to infirmary building, including steam heating equipment. Estimated cost $900,000. Mas-Farlane, Maul & Lentz, 1257 David Whitney Bldg., Detroit, Archts.

Minn., Foxhome—The village plans the construction of a waterworks system and mains, also the installation of pump equipment. Estimated cost $15,000. Engineer not announced.

Minn., Marietta—The village is having plans prepared for a waterworks system, 200 ft. well, pumping equipment, mains, steel tower and tank, 30,000 gal. capacity. Estimated cost $24,000. W. E. Buell & Co., 205 Davidson Bldg., Sioux City, Ia., Engrs.

Minn., St. Cloud—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will receive bids until Nov. 14 for one electric passenger elevator for building at the United States Veterans' Hospital, here.

N. J., Trenton — J. O. Hunt, Engr. and Archt., 219 East Hanover St., will receive bids until Nov. 6 for the construction of a 4 story building for the Young Women's Christian Association, 141 East Hanover St. Estimated cost $600,000. Equipment detail not reported. Former bids rejected. Noted Sept. 25.

N. Y., Albany—The Albany Hospital received bids for furnishing and installing heating and ventilating system for hospital for contagious diseases from the Austin Eng. Co., Albany, $24,375; M. J. Hawkins, 46 Orange St., $20,897; W. B. Armstrong Co., 3 Fulton St., $23,323. Contract for the construction of a concrete subway to carry steam pipes from power house to hospital was awarded to E. B. Stevenson, $8,674. Noted Oct. 9.

N. Y., Brooklyn—The Abraham Lincoln Apartment, Inc., c/o S. Malkind, Archt., 16 Court St., is having plans prepared for the construction of a 4 story, 250 x 450 ft. apartment house on Bay Parkway. Estimated cost $900,000. Equipment detail not reported.

N. Y., Montgomery—W. Crabtree & Sons are having plans prepared for remodeling boiler house and the installation of boiler equipment. Lockwood, Greene & Co., 101 Park Ave., Engrs.

N. Y., New York—The city, Bellevue & Allied Hospitals, A. Judd, Chn. Bldg. Com., East 26th St., is having plans prepared for the construction of a refrigeration plant. Estimated cost $65,000. Private plans.

N. Y., New York—The Mandel Ehrich Corp., c/o J. Sloane, Engr. and Archt., 100 East 42nd St., has had plans prepared for the construction of an apartment house on Park Ave. and 36th St. Estimated cost $500,000. Equipment detal not reported.

N. Y., New York—The One Hundred Fifteen East 48th St. Corp., c/o M. B. Schmidt, Engr. and Archt., 14 East 46th St., is having plans prepared for the construction of a 14 story apartment house on 48th St. and Lexington Ave. Estimated cost $3,000,000. Equipment detail not reported.

N. Y., New York—The Seventy Third St. & Amsterdam Ave. Corp., c/o Sugarman, Hess & Berger, Engrs. and Archts., 16 East 43rd St., is having plans prepared for the construction of a 15 story apartment house on West 73rd St. Estimated cost $900,000. Equipment detail not reported.

N. Y., Niagara Falls—The Certainteed-Products Co., Elizabeth St., is in the market for refrigeration machinery and equipment for new warehouse.

N. Y., Rochester — The Rochester Refrigerating Co., 1980 East Ave., R. Tomlinson, Pres., is in the market for refrigeration machinery and equipment for proposed addition to contain 100,000 sq.ft. of floor space.

N. Y., Troy — Wright's Health Underwear Co., 2nd Ave., North, J. Burke, Mgr., is in the market for 220 volt, 3 phase, 40 cycle motors from 3 to 50 hp., making a total of about 200 hp., complete with overload and undervoltage protection, compensators, etc.

N. C., Badin — The Tallahassee Power Co. plans to build a large dam across the Yadkin River, to form a reservoir to cover 30 sq.mi.

N. C., Balfour—E. A. Smythe, c/o Chamber of Commerce, Hendersonville, plans to build a 25,000 spindle cotton mill, here. Estimated cost about $1,000,000.

N. C., Burlington—The Community Refrigerating Co. is in the market for a 20 ton electrically driven ice plant for Jacksonville, Fla.

N. C., Wilmington—The Cape Fear Hotel Co. has had plans prepared and will soon receive bids for the construction of an 8 or 10 story hotel on 2nd and Chestnut Sts. Estimated cost $850,000. G. L. Preacher & Co., Commercial Bank Bldg., Raleigh, Archts. Equipment detail not reported.

Ohio, Akron—A. C. Smith, c/o T. R. Ridley, Archt., 109 North Union St., is having plans prepared for the construction of a 5 story hotel, to contain 500 rooms. Estimated cost $500,000. Equipment detail not reported.

Ohio, Canton — The Aultman Hospital Assn. plans to build a 3 story addition to hospital on Clarendon Ave., S. W. Estimated cost $300,000.

Ohio, Cleveland—The City Ice & Fuel Co., Cadillac Bldg., C. C. Coneby, Constr. Mgr., is having revised plans prepared for the construction of a 1 story, 66 x 184 ft. ice plant on East 124th St. and Union Ave. Estimated cost $60,000. Arctic Ice Machine Co., 920 Market Ave., Canton, Archts. Sormer bids rejected. Noted Oct. 16.

Ore., Portland—The City Comn., J. H. Mann, City Hall, Comr., is having plans prepared for the construction of a garage and machine shop on Montgomery and Larabee Sts. Estimated cost $150,000. O. Laurgaard, City Hall, Engr. Equipment will include engines, boilers or electric motors, etc.

Pa., Millvale (Pittsburgh P. O.)—G. W. Bauer, Borough Clk., will receive bids until Nov. 1 for one vertical and one horizontal motor driven centrifugal pump with shafting, motors, etc., for waterworks station. J. N. Chester, Union Bank Bldg., Pittsburgh, Engr.

Pa., Morrisdale—Morris Twp. School Bd., W. Slee, Pres., will receive bids until Oct. 31 for installing steam heating system in 98 x 110 ft. school building. O. M. Overdorf, Dubois, Engr.

Tenn., Chattanooga—The Atlantic Ice & Cold Storage Co. plans to build an addition to cold storage plant. Estimated cost $75,000. Engineer or architect not selected.

Tenn., Nashville — The city, E. Howse, Mayor, plans to expend about $2,000,000 for modernizing present water plant, building additional force mains and installing pumping equipment, etc. Noted July 31.

Tex., Brownsville—The Green Hotel Co., c/o J. H. Green, has had plans prepared for the construction of a 6 story hotel. Estimated cost $375,000. Everson & Co., Chicago, Engrs. and Archts. Equipment detail not reported.

Tex., Clifton—The city, J. Wise, Secy., will receive bids until Nov. 2 for complete installation of one 100 hp. and one 150 hp. oil engine generating unit, switchboards, poles, wire, meters, etc. Cost will exceed $25,000.

Tex., Ennis—The City Comn. is receiving bids for two 5 hp. electric belt drive engines, 6 type; two 5 hp. 2 stage centrifugal pumps, 700 g.p.m. against 150 ft. head; fittings, etc. Former bids rejected.

Vt., Morrisville—The village is having plans prepared for hydro-electric power development to include the construction of a concrete dam, power house, etc., and the installation of one 850 hp. and one 1,700 hp. vertical unit. Estimated cost $150,000. C. A. Slayton, Morrisville, Engr.

Va., Farmville—The city voted $50,000 for improvements to electric light plant.

Va., Virginia Beach—The Pennsylvania R.R., Broad St. Sta., Phila., the Norfolk & Western R.R., Norfolk & Southern R.R. and the Norfolk & Washington Steamship Line, Front St., Norfolk, are promoting the construction of a hotel, here. Estimated cost $3,000,000.

Wash., Seattle—The city will hold an election in the spring to vote $750,000 bonds for the construction of an auditorium, seating capacity 10,000.

W. Va., Belington—The city plans to rebuild its power plant which was destroyed by fire. Estimated cost $40,000.

W. Va., Charleston—E. F. Morgan, Governor, will receive bids until Dec. 1 for the construction of a 4 story capitol building on Duffy St. Estimated cost $2,500,000. C. Gilbert, 244 Madison Ave., New York, Archt. Equipment detail not reported.

W. Va., Welch—A. M. Robinson is in the market for a 300 hp. gasoline engine (used preferred).

Wis., De Pere—W. G. Kirchoffer, Engr., Dean Bldg., Madison, has been selected by the city to investigate additional water supply and will receive bids as soon as report is made. Additional pumping equipment will be required. Estimated cost $15,000.

Wis., Fond du Lac—The Bd. of Public Wks., J. F. Hohensee, Secy., will soon award the contract for the construction of an addition to sewage pumping station. The contract for ejector was awarded to the Yeomans Bros. Co., 1433 Dayton St., Chicago, $1,255. Noted Oct. 9.

Wis., Madison—G. Gropas, 908 Jenifer St., is in the market for refrigeration machinery, etc., for proposed restaurant. F. Riley, Conklin Bldg., Archt.

Wis., Madison—The University Union, J. Dollard, Secy. Bldg. Com., is having plans prepared for the construction of a 4 story, 176 x 260 ft. union memorial building on Langdon St. Estimated cost $1,200,000. A. Peabody, Capitol, Madison, Archt. Eschweiler & Eschweiler, 210 Mason St., Milwaukee, Associate Archts. Equipment detail not reported.

Wis., Menasha—The city, J. F. De Caro, Clk., is receiving bids for a 600 hp. oil burning engine for water and light plant.

Wis., Milwaukee—The city, Central Bd. of Purchases, received one bid for a feed water heater for the Riverside pumping station from the Cochrane Eng. Co., 53 West Jackson Blvd., Chicago, $11,183 and $10,479. Noted Oct. 16.

Wis., Waunakee—H. R. Burr is in the market for thirteen motors, total about 125 hp., for canning factory.

B. C., Essondale—The Provincial Government, Dept. of Public Wks., Victoria, is having plans prepared and will receive bids about Nov. 1 for a central heating plant, including chimney, for the hospital, here. Estimated cost $200,000. P. Philip, c/o owner, Engr. H. Whittaker, c/o owner, Archt.

Ont., Belleville — The city will soon receive bids for the construction of a pump house and a gasoline driven fire pump, about 3,000,000 gal. capacity. Estimated cost $25,000. Gore, Nasmith & Storrie, Confederation Life Bldg., Toronto, Engrs.

Ont., Cutler—The Spanish River Lumber Co., Ltd., W. J. Bell, Mgr., is having plans prepared for rebuilding lumber and sawmill, to replace the one which was destroyed by fire. Estimated cost $200,000. Private plans. The owner is in the market for steam power plant, etc.

Ont., Matheson—R. Potter plans to rebuild sawmill, which was recently destroyed by fire, and is in the market for steam power plant, etc.

Ont., Niagara Falls—The city will hold an election Dec. 3 to vote on the construction and equipment of an artificial ice rink. Estimated cost $30,000.

Ont., Port Arthur — The Port Arthur Arena Co. is having plans prepared for the construction of a 1 and 2 story skating arena, including steam heating system. Estimated cost $150,000. C. D. Howe & Co., Port Arthur, Engrs.

Ont., Port Colborne—The City Council is having plans prepared for a waterworks plant, including storage basin, pump house, two 750 gal. motor driven pumps, one 1,500 gal. gasoline driven pump, three pressure filter units, 12 in. main and 2,000,000 gal. elevated tank. Estimated cost $90,000. E. H. Darling, Home Bank Bldg., Hamilton, Engr. The owner is interested in prices of materials and equipment. Noted June 26.

Ont., Toronto—The Toronto Hydro-Electric System, Eyne Bldg., E. M. Ashworth, Acting Mgr., is having plans prepared for the purchase and installation of electric plant and equipment, including cable, wire, insulation, insulators, poles, transformers, switches, meters, etc. Estimated cost $1,940,000. Private plans.

Que., Levis—L. N. Huard, 129 Commerciale St., plans the developent of 17,000 hp. on the River Megiscane, Temiscaminque County, and will receive bids about Dec. 15.

CONTRACTS AWARDED

Calif., Byron — The Byron-Bethany Irrigation Dist. awarded the contract for furnishing and installing a centrifugal pump, 9 sec.ft. capacity, 15 ft. head, 12 in. discharge, 575 r.p.m., 20 in. steel discharge pipe and fittings; two 14 in. gate valves; two electric priming units; one electric induction motor, 2,200 volt, 3 phase, 60 cycle, 40 hp., 575 r.p.m., direct connected to pump, to the Byron-Jackson Iron Wks., Sharon Bldg., San Francisco, $3,561. Noted Oct. 9.

Calif., Santa Monica — G. F. Stephenson, 21 41st Ave., awarded the contract for the construction of a 6 story hotel and apartment house to Gutleben Bros., I. W. Hellman Bldg., Los Angeles. Cost will exceed $250,000. Equipment detail not reported.

Ill., Chicago—The Western Electric Co., 22nd and Cicero Sts., awarded the contract for the construction of a 4 story, 160 x 180 ft. warehouse on Koster St. near Ogden Ave., to J. Bhedden & Co., 160 North La Salle St. Estimated cost $1,000,000. Steam heating system will be installed. Noted May 1.

Mass., Stoneham (Boston P. O.) — The Metropolitan Dist. Comn., 1 Ashburton Pl. Boston, G. L. Rogers, Secy., awarded the contract for furnishing and installing a crank and flywheel cross compound pump, 20,000,000 g.p.d. capacity, to the Worthington Hunt Mchy. Corp., 115 Broadway, New York. Estimated cost $69,000. Noted Sept. 11.

Miss., Jackson—The state awarded the contract for the construction of a 3 story hospital at Beauvoir Soldiers Home to W. T. Beckelhimer, Hattiesburg, $377,990. Equipment detail not reported.

N. Y., Buffalo—Walbridge & Co., Main St., awarded the contract for the construction of a 10 story store and office building on Court St. to D. P. Robinson & Co., Inc., 125 East 46th St., New York. Estimated cost $500,000. Equipment detail not reported. Noted June 12.

N. Y., New York — R. Campagna, 200 West 72nd St., will build an apartment house at 320 West End Ave., by day labor. Estimated cost $500,000. Equipment detail not reported.

N. Y., New York—The Sherman Elwood Bldg. Corp., c/o Margon & Glaser, Archts., 2804 3rd Ave., will build a 14 story, 86 x 160 ft. apartment house on Park Ave. and 39th St. by day labor. Estimated cost $1,110,000. Equipment detail not reported.

N. Y., New York—H. and S. Sonn, Inc., c/o Margon & Glaser, Archts., 2804 3rd Ave., will build a 14 story, 75 x 175 ft. apartment house on 39th St. and Park Ave. by day labor. Equipment detail not reported.

N. C., Fayetteville — The Fayetteville Hotel Co. awarded the general contract for the construction of an 8 story hotel to the J. A. Jones Constr. Co., Realty Bldg., Charlotte, $249,000; heating, etc., to the Toomey Plumbing & Heating Co., 29 South Church St., Charlotte, $49,790. Noted Sept. 25.

N. C., Greenville—The Teachers Training College, R. H. Wright, Pres., awarded the contract for the construction of an addition to power plant to the Dermott Heating Co., Durham, $122,750.

Ohio, Mansfield — The Natl. Ice Co. awarded the contract for the construction of a 1 story, 41 x 60 ft. ice plant to Snell & Wolff, Mansfield. Estimated cost $50,000. Noted Oct. 2.

Pa., Phila.—The Amer. Ice Co., 121 North Broad St., awarded the contract for the construction of a 3 story, 57 x 150 ft. ice storage and manufacturing plant on 17th and South Sts. to Sutton & Stephensen, 13th St. and Washington Ave. Noted Sept. 18.

Tenn., Shelbyville—The Shelbyville Light & Power Co. awarded the contract for the construction of a hydro-electric plant and dam on the Duck River to the Foster Creighton Co., 4th and 1st Natl. Bank Bldg., Nashville. Estimated cost $50,000.

Tex., Kerrville—The city awarded the contract for a 75 hp. Worthington motor driven pump, etc., to G. E. Ginter, Calcasieu Bldg., San Antonio, $10,707. Noted Sept. 25.

Wis., Green Bay—The Badger Show Case Co., 133 North Pearl St., awarded the contract for the construction of a 2 story, 60 x 162 ft. factory and a 37 x 42 ft. boiler house and dry kiln to F. De Coster, 1011 Mather St., Green Bay. Estimated cost $50,000.

Wis., Madison—The city, L. L. Smith, Supt., awarded the contract for additional water supply, including wells and equipment, to the Layne-Bowler Co., 37 Van Buren St., Chicago. The owner will purchase pumping equipment.

Wis., Medford — The Medford Canning Co., c/o J. B. Weix, Mgr., Oconomowoc, will build a cannery, consisting of a 3 story, 50 x 120 ft. main building, a 1 story, 100 x 128 ft. warehouse and a 40 x 40 ft. power house, by day labor, here. The owner is in the market for two 150 hp. boilers, auxiliary engine, conveyors and canning machinery equipped with motors.

Wis., Verona—Dane County, c/o M. Sommers, Chn., Madison, awarded the contract for piping, fittings, valves, generators, etc., for power house, here, to the Wisconsin Machine Co., 623 East Main St., Madison. Noted Jan. 30.

Man., Winnipeg — The Hydro-Electric System awarded the contract for three units, 7,300 hp. each, delivery to be made in three successive years, 1924, 1925 and 1926, for development of additional power at the Point Du Bois plant, to the Vickers Co. of England. Estimated cost $283,000. This will enable the hydro system to deliver an additional 30,000 hp. by 1926.

Quebec—The Province of Quebec awarded the contract for the construction of a dam on the Metis River to furnish water power for the counties of Matane, Rimouski, Matapedia, Gaspe and Bonaventure, to the Newton Dalsin Constr. Co., 10 Cathcart St., Montreal, $109,557.55.